

JOURNAL OF THE
BOSTON SOCIETY
OF
CIVIL ENGINEERS

MAY, 1930

Featuring

**Stream-Flow Data—Its
Collection and Use**



Vol. XVII

No. 5

BOSTON SOCIETY OF CIVIL ENGINEERS

OFFICERS, 1930-1931

PRESIDENT

LEWIS E. MOORE

VICE-PRESIDENTS

HARRY E. SAWTELL

(Term expires March, 1931)

RALPH W. HORNE

(Term expires 1932)

SECRETARY

EVERETT N. HUTCHINS

TREASURER

FRANK O. WHITNEY

DIRECTORS

ARTHUR L. SHAW

HENRY A. VARNEY

(Term expires March, 1931)

JOHN B. BABCOCK, 3d

HAROLD K. BARROWS

(Term expires March, 1932)

PAST PRESIDENTS

(Members of the Board)

FRANK A. MARSTON

CHARLES B. BREED

FRANK E. WINSOR

SANITARY SECTION

HARRISON P. EDDY, JR., Chairman

GEORGE G. BOGREN, Clerk

DESIGNERS SECTION

NORMAN P. RANDLETT, Chairman

LAWRENCE G. ROPES, Clerk

HIGHWAY SECTION

JAMES E. LAWRENCE, Chairman

ERNEST MATHERS, Clerk

NORTHEASTERN UNIVERSITY SECTION

JOHN H. LOWE, Chairman

CARL A. MAGNUSON, Clerk

Editor — EVERETT N. HUTCHINS

715 Tremont Temple, Boston

JOURNAL OF THE BOSTON SOCIETY OF CIVIL ENGINEERS

Volume XVII

MAY, 1930

Number 5

CONTENTS

PAPERS AND DISCUSSIONS

PAGE

Stream-Flow Data — Its Collection and Use. <i>H. B. Kinnison</i>	171
Discussion by <i>Prof. H. K. Barrows, Howard M. Turner, Edward A. Graustein, Truman H. Safford</i>	242

OF GENERAL INTEREST

Awarded to the Lowest Bidder. <i>Edward Grossman</i>	249
Proceedings of the Society	252
Book Reviews	254

Published Monthly, except July and August, by the Society
715 Tremont Temple, Boston, Massachusetts

Subscription Price, \$4.00 a Year (10 Copies)
50 Cents a Copy

Copyright, 1930, by the Boston Society of Civil Engineers.
Entered as second-class matter, January 15, 1914, at the Post Office
at Boston, Mass., under Act of August 24, 1912.

Acceptance for mailing at special rate of postage provided for in
Section 1103, Act of October 3, 1917, authorized on July 16, 1918.

*The Society is not responsible for any statement made or opinion
expressed in its publications.*

BOSTON
WRIGHT & POTTER PRINTING COMPANY
32 DERNE STREET

JOURNAL OF THE BOSTON SOCIETY OF CIVIL ENGINEERS

Volume XVII

MAY, 1930

Number 5

STREAM-FLOW DATA — ITS COLLECTION AND USE

By H. B. KINNISON,* MEMBER, BOSTON SOCIETY OF CIVIL ENGINEERS

(Presented at the meeting of the Society on April 16, 1930)

INTRODUCTION

MODERN civilization is infinitely more dependent upon an adequate supply of water than ever before. It is practically as essential to the different phases of man's present activities as it is to all forms of life itself. We have always used water, — at first for domestic purposes only, then progressively for navigation, irrigation, water power, sanitation, industry and hydro-electric energy, until now its use enters all aspects of modern activity.

In all sections of the United States communities are finding it more and more difficult to supply the growing demand for pure water in greater abundance for domestic purposes. Future needs of a city can readily be determined and plans for the provision of these needs must be made years in advance, for, in the words of William Mulholland, "if you wait until you have to have water, then you won't need it."

Its use for irrigation has made possible the development of great areas of arid or semi-arid land, with the resultant increase of wealth, accompanied by the growth of beautiful and prosperous states.

The processes of industry involve the use of large quantities of water, and for some of these industries the water must conform to certain standards of quality. Due to the increase of our population and indus-

*District Engineer, Water Resources Branch, United States Geological Survey, Custom House, Boston, Mass.

trial development, serious problems have arisen because of the pollution of our rivers. The manner of disposing of the industrial waste and sewage will depend upon the amount of water flowing in the near-by streams.

For quantity production of electrical energy, either by steam or hydraulic, great quantities of water are required. At times of floods our streams, which constitute one of our major natural resources, may become a menace to life and property.

It is necessary that a dependable supply of water be available, whether it be for domestic purposes, sewage disposal, development of industry, development of electricity, protection from floods, irrigation of land, determination of probable drought or flood for the purpose of insurance protection, or for any of the many other problems concerning water.

The time will undoubtedly come when New England will agree with the far West that pure water, our most common natural resource, is our most valuable mineral. Because of our more abundant supply, it will not be necessary to conserve to such an extent as they are doing over vast areas in the West, where even now development is fast reaching its limit as defined by the available water supply. If the West is fast approaching its limit of extensive development, consideration should be given to the unusual demands which will be made upon our water supply when it becomes necessary to take care of more than our share of the natural development and growth of the nation's population. There is no doubt but that water supply will eventually be the limiting factor in the development of many communities. Other factors being equal, those communities with the best supply should be developed first.

NEED FOR STREAM-FLOW DATA

For any resource that enters so intimately into many human activities and in an ever-increasing range is becoming a limiting factor in development, reliable information is essential. Engineers need definite facts as a basis for design, construction and operation, not only of hydraulic works but of other structures erected on the banks or on the flood plains of rivers. Financiers must be assured by unbiased records showing that the necessary water is available to warrant the estimates of returns to be obtained by a proposed development. Lawyers and courts base their opinions and decisions in litigation relating to damages and adjudications connected with streams upon systematic records of facts relating to stages and quantities of water. State officials administer the laws,

distribute the water, and regulate activities in accordance with the accepted records of water supply. City officials plan water-supply systems, promote the establishment of industries, and in general exercise police power in many directions on the basis of records of river discharge.

The city and state are therefore interested in having reliable records of water supply as a basis for distributing the water supply among various users, regulating activities, and promoting economic development and utilization of regional resources and the legitimate increase in taxable property. Without such records all development will be hazardous, ill-advised projects will be constructed, failures will surely occur, and, as a result, proper development will be retarded.

The time to secure information concerning our water resources is not at the time when necessity for the data arises. If you wait until you need the data none will be available and extensive development will be delayed or abandoned. Unfortunately, the dependability and magnitude of a water supply can only be estimated for the future upon its behavior over a long period in the past. There is no doubt but that our longest records are too short to cover all extremes of flow and that the longer the records the more dependable they become.

Private companies or individuals cannot be expected to start the collection of stream-flow information years in advance of the time of their first development on a river. Such a study rightfully belongs to a governmental agency having a policy looking toward the future development of all natural resources. Such an organization is the United States Geological Survey, which realized years ago that information on our streams would be necessary for their ultimate development. Since that time, it has worked continuously toward the development and improvement of methods employed in the collection of stream-flow data, until at this time its methods have been adopted as standard throughout the world. It is primarily an investigational bureau, dealing generally with natural resources, and is recognized as competent and unbiased. Its stream-flow information is published in a series of yearly reports treating exclusively of water and its utilization.

COLLECTION OF DATA

In the collection of stream-flow data many gaging stations have been established on the principal rivers and their tributaries in the United States. Approximately twenty-five hundred such stations are being operated at the present time. In the establishment of a stream-gaging station, primary consideration should be given to the selection

of the gaging station control. "Control" is defined as the natural section or stretch of the channel, or artificial structure, below the gage which determines the stage-discharge relation at the gage. It should be noted that as the stage of the river changes the control may change from one cross-section to another, or from a cross-section to a long stretch of channel, or *vice versa*. In the case of a sharply defined natural control, such as that formed by an outcropping of rock, a gravel bar or an artificial control or weir, the channel of approach and the channel of discharge should be considered a portion of the control, since changes in these would affect the stage-discharge relation at a point immediately upstream from the control. Fig. 1 shows a ledge rock control on

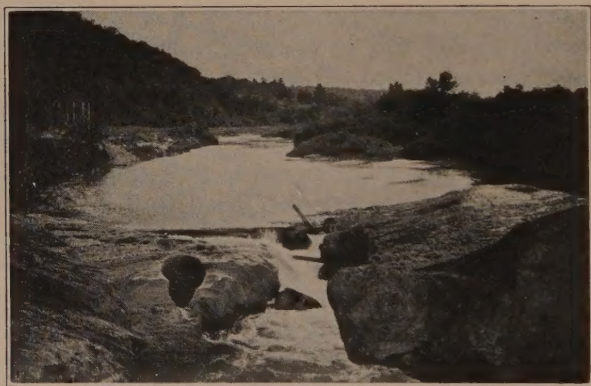


FIG. 1. — NATURAL CONTROL ON LAMOILLE RIVER, AT JOHNSON, VT.

the Lamoille River at Johnson, Vt. As a general rule, especially on undeveloped rivers, it is possible to find satisfactory natural controls. However, artificial controls of stone or concrete are being constructed on many of the smaller streams throughout the United States, due to the desire to create a stable condition at the control, so that the relation between gage height and discharge will remain constant. Such an artificial control, built between boulders on the Ware River above Gibbs Crossing, Mass., is shown on Fig. 2.

As the streams become more highly developed, natural controls become covered by backwater from dams. At the present time, because of the complete development of several of our streams, it is impossible to locate a natural control for a gaging station, and it will likely become increasingly more desirable to make use of existing power plants or the

power plants of future developments for the purpose of determining the daily discharge of our rivers. Because of the extensive work required to arrive at the daily discharge of a river by means of records of operation of present power plants but few of these have been utilized for this purpose. However, considerable progress has been made in the development of instruments for the purpose of arriving at the total discharge



FIG. 2. — ARTIFICIAL CONTROL, WARE RIVER, ABOVE GIBBS CROSSING, MASS.

through the units at some of the newer power plants. This may become an important feature of stream gaging as the rivers become more completely developed.

GAGING STATIONS AND EQUIPMENT

Having selected a satisfactory control, it is necessary to establish immediately above the control a gage for the purpose of determining the height of the water. As the need for more dependable records has increased during recent years, nonrecording gages of the vertical or

inclined staff type, or the chain gage, are being replaced with recording gages which give a constant, continuous graph of the height of the water at all times, making it possible to determine exactly the mean gage height for any period of time. These are more essential on flashy streams, or on streams with extensive diurnal regulation.

The action of recording instruments in general use by the United States Geological Survey is controlled by the rise and fall of a float resting on top of the water in a well which is dug in the bank of the river to an elevation lower than the minimum stage. The instrument is placed in a shelter erected directly over the well, at an elevation

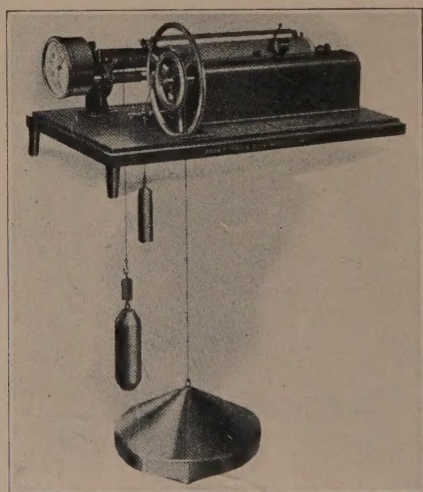


FIG. 3.—AU WATER STAGE
RECORDER

higher than probable maximum stage. Such a recording instrument is shown in Fig. 3. The water level inside the well is kept at the same elevation as the water surface in the river by means of an open pipe joining the bottom of the well to the river, through which water is allowed to flow into or leave the well. The rise and fall of the float on the surface of the water actuates the recording pencil on the instrument, which marks continuously the stage of the river on a chart. The chart moves at a uniform rate of speed, due to the action of a clock mechanism.

In past years, due to the lack of funds, it was generally customary to build the well and instrument shelter of wood. These structures

were short-lived. During recent years, reinforced concrete has been employed for their construction, and should be permanent. Fig. 4 illustrates the method of installing a reinforced concrete well and shelter while Fig. 5 shows the completed structure of the gaging station on the Connecticut River at Montague City, Mass. Fig. 6 shows a cable with its supports and two gaging cars at a point on the Connecticut River immediately below the Montague City station. Similar cables are erected across rivers at stations where other structures are not



FIG. 4.—CONSTRUCTION WORK ON REINFORCED CONCRETE WELL, SHOWING TRENCH FOR INTAKE PIPE



FIG. 5.—REINFORCED CONCRETE WELL AND SHELTER, CONNECTICUT RIVER, MONTAGUE CITY, MASS.

available from which discharge measurements can be made and must be of sufficient height so that the cars will be above probable maximum stage. Such a cable is shown in Fig. 7.

RATING CURVE

The station rating curve is one showing the relation between gage height and discharge for all stages of the river. The determination of the position of this curve requires the making of current meter measurements of discharge at a number of elevations, ranging from the extreme

low to the extreme high stage. By plotting the results of these measurements of discharge on rectangular co-ordinate paper, using gage height in feet as ordinates and discharge in cubic feet per second as abscissa, and drawing a smooth curve through these points, a station rating curve is obtained. After a sufficient number of discharge measurements have been secured accurately to define the rating curve, a rating table is prepared which shows for each one-tenth or one-hundredth of a foot of gage height the corresponding discharge. From this table is taken the discharge corresponding to the mean gage height for each day of the year, which is entered in a table of discharge, and after which the monthly and yearly discharges are computed.



FIG. 6. — A FRAME SUPPORTING CABLE AND CARS, CONNECTICUT RIVER, MONTAGUE CITY, MASS.

It seldom is possible to secure sufficient measurements, especially at high stages, to determine the position of the upper end of the rating curve. It therefore becomes necessary to extend the rating curve to the highest stage recorded at the gaging station. Should the measurements define the curve to a fairly high stage, it is usually possible to extend the curve with sufficient accuracy by the use of parabolic curves. The general form of a station rating curve is a parabola which takes the form of a straight line when plotted in a certain manner on logarithmic paper. Should it be necessary to extend the curve over a considerable range of stage it is often of benefit to plot the discharge measurements on logarithmic paper in such a manner that the points fall on a straight line, which may readily be extended. In most cases when measurements

are so plotted to the observed gage heights it is found necessary to add or subtract such a constant from the observed gage height of each measurement, so that the plotted points fall on a straight line. However, a rating curve may have two, three or more phases, usually depending upon the shape of the cross-section at the control, only one of which can be shown as a straight line with a single plotting. Considerable care and judgment, based upon the knowledge of the station control and the con-



FIG. 7. — CABLE CAR FOR MAKING
DISCHARGE MEASUREMENTS

ditions of the river channel below the station, must be exercised in the use of this method of rating curve extension. Fig. 8 is the rating curve for the gaging station on the Connecticut River at White River Junction, Vt. The upper position of the curve has been effective since the flood of November, 1927, and shows by its position above the former curve the filling action of the flood. Fig. 9 illustrates the method of developing the straight line rating curve on logarithmic paper for the gaging station on the Winooski River at Montpelier, Vt.

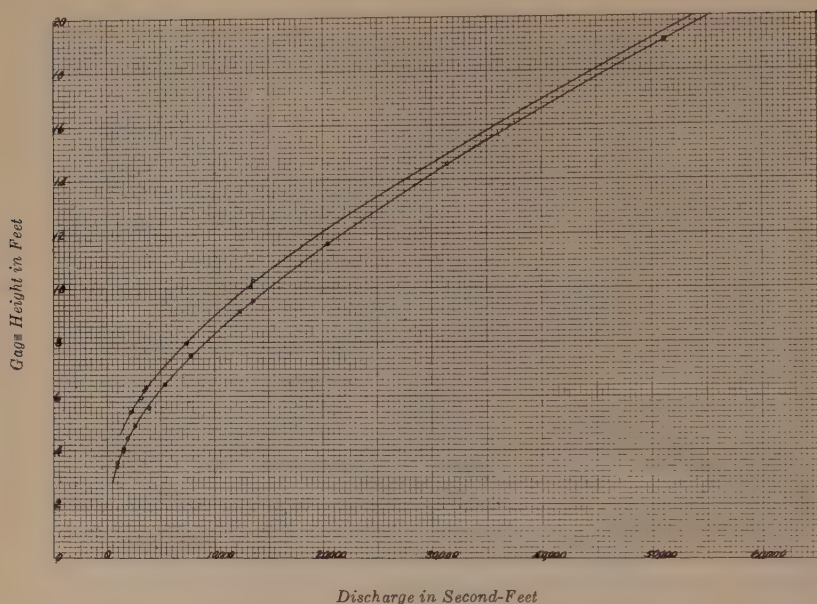


FIG. 8.—RATING CURVE FOR CONNECTICUT RIVER AT WHITE RIVER JUNCTION, VT.

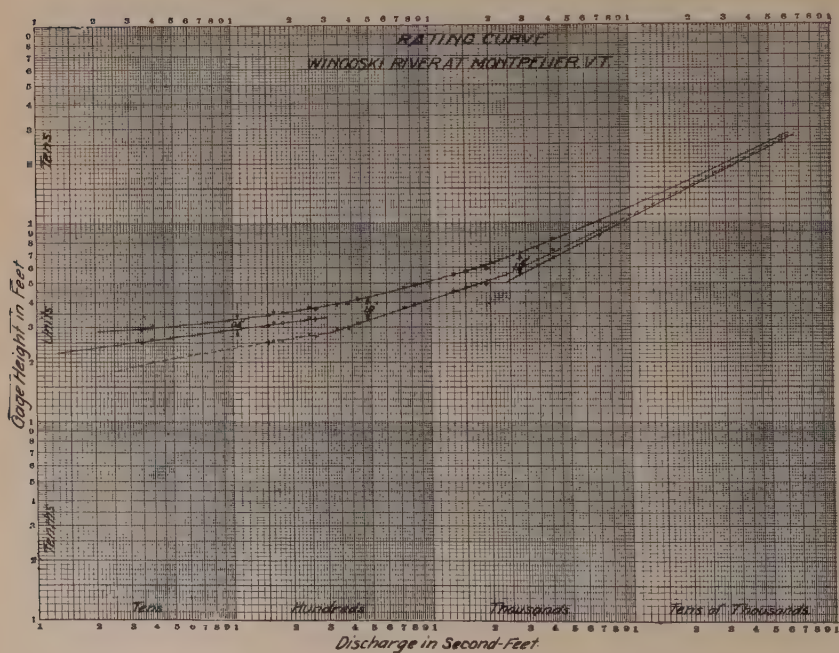


FIG. 9.—RATING CURVE, WINOOSKI RIVER, AT MONTPELIER, VT.

The technique of making discharge measurements by current meter and the preparation of rating curves and allied subjects are fully described in a publication "River Discharge,"* and also in the publication "Stream Gaging"†.

DETERMINATION OF PEAK FLOW

In connection with the determination of the correct position of the upper end of a station rating curve, it is occasionally possible to compute

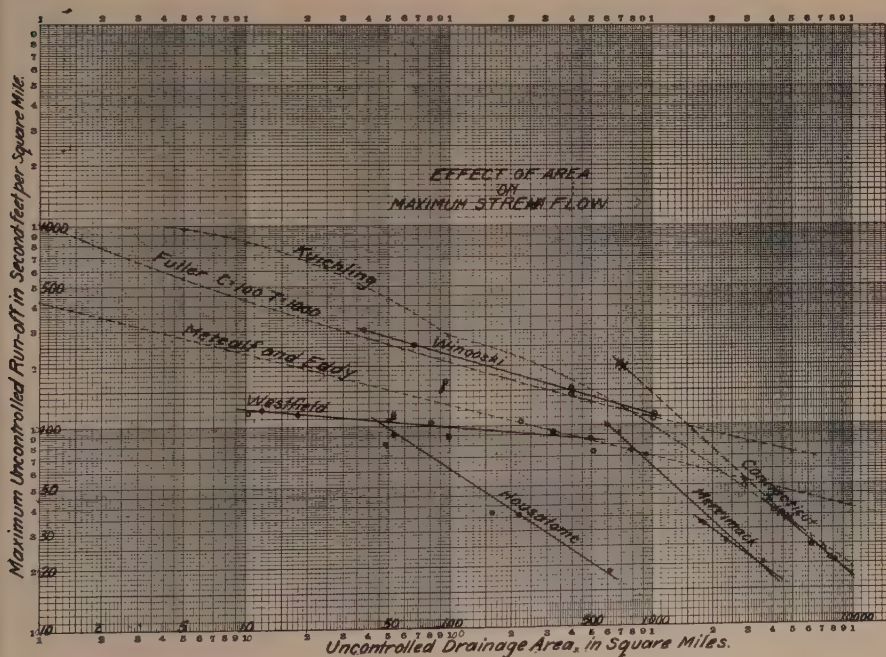


FIG. 10. — EFFECT OF AREA ON MAXIMUM STREAM FLOW

the discharge for the peak of a flood after the flood has subsided. Extensive studies of this nature were made following the New England flood of November, 1927, the results of which are published in United States Geological Survey, Water-Supply Paper, 636-c. On many of the New England streams the determination of the peak flow was made at several points on the same stream. Fig. 10 is a study of these results with the points plotted logarithmically, straight lines being drawn

* "River Discharge," by John Clayton Hoyt and Nathan Clifford Grover.

† "Stream Gaging," by William Andrew Liddell.

through those points on the same stream. Similar lines are shown corresponding to some of the more common flood formulas. It is interesting to note that, with few exceptions, the greater the drainage area on a stream the smaller the peak discharge in second-feet per square mile.

The flood peak on the Connecticut River below White River Junction, Vt., originated in the White River. This peak reached White River Junction so far in advance of the flood water from the tributaries of the Connecticut River farther upstream that for the purpose of studying this peak alone the drainage area of 3,330 square miles above the mouth of the White River and the water from this area can be disregarded. By deducting this drainage area and its estimated discharge at the time of the peak at White River Junction from the respective drainage areas and peak discharges for points below the mouth of the White River other points indicated by crosses are obtained. The dotted line drawn through these crosses and through the point for the White River at West Hartford, Vt., the highest point on the dotted line, indicates the position of the Connecticut River curve when the White River is considered the main Connecticut River and the upper river is disregarded.

RELATION BETWEEN GAGE HEIGHT AND DISCHARGE

Because the relation between the gage height and discharge at a gaging station is not a straight line, an erroneous value for daily discharge is obtained by the use of the mean daily gage height unless it remains practically constant throughout the day. In cases of considerable diurnal fluctuation this error becomes so great that it cannot be disregarded, and in order that it may be eliminated it is necessary to integrate the daily discharge. This is done by either of two methods. First: the day can be divided into a number of periods and the discharge for each period determined in arriving at the mean for the day. Second: in order to facilitate the work entailed in carrying out the above method, the United States Geological Survey has developed and built the discharge integrator, ten of which are in existence at the present time. This instrument gives a summation of values obtained from a continuous application of the rating curve to the stage of the river as indicated by the gage height record throughout the twenty-four-hour period, and is described in a JOURNAL of the Boston Society of Civil Engineers.*

* "The Discharge Integrator," by C. H. Pierce, Journal of the Boston Society of Civil Engineers, Vol. 4, No. 7, September, 1917.

ACCURACY OF DATA

For many years engineers have made measurements of the discharge of flowing water by various means without being able, except in very few cases, to know within what degree of accuracy their work has been done. In recent years the small Price current meter has been used exclusively by the United States Geological Survey because of its adaptability to all of the many conditions encountered in the field. By keeping the meters well rated, the instrument in perfect mechanical condition, and by making a careful selection of the site for the discharge measurement, it has been considered that measurements properly made under the best of conditions should be within 2 per cent, and certainly within 5 per cent, of the true discharge.

An unusual opportunity recently presented itself to compare a current-meter determination of discharge against a salt-velocity determination of discharge at the time of the acceptance tests for the units installed at Bellows Falls, Vt., following the redevelopment of the Bellows Falls power plant. The power at this plant is developed by leading water through a canal from a pond above a dam across the Connecticut River at Bellows Falls to the power plant at the lower end of this canal, where the water is dropped about 60 feet to the river bed below. The width of the canal at the surface is 100 feet; the depth is about 28 feet; the slope of the sides 1 to 1 $\frac{1}{4}$ feet; and the width of the bottom is 35 feet. The sides of the canal are lined with mortarless masonry, with reinforced concrete ribs built flush with the masonry and spaced 20 feet apart. The bottom is lined with rough masonry partially covered with gravel. The velocity of the water in the canal reached a maximum during the test of 6.56 feet per second.

A concrete arch bridge spanned the canal at the upper end of the section used for the salt-velocity tests. The salt for these tests was injected into the stream at the upstream side of this bridge. The current meter measurements were made from the downstream side of the bridge. The spring line of the arch was below the surface of the water and caused a back eddy on each side of the canal immediately below the bridge. In order to reduce these eddies so that their effect upon the salt-velocity tests would be as small as possible, rafts were tied over the eddies, thus partially smothering them. There was a slight bend in the canal at the bridge and also a small angle in the center of the section of the canal used for the salt-velocity tests.

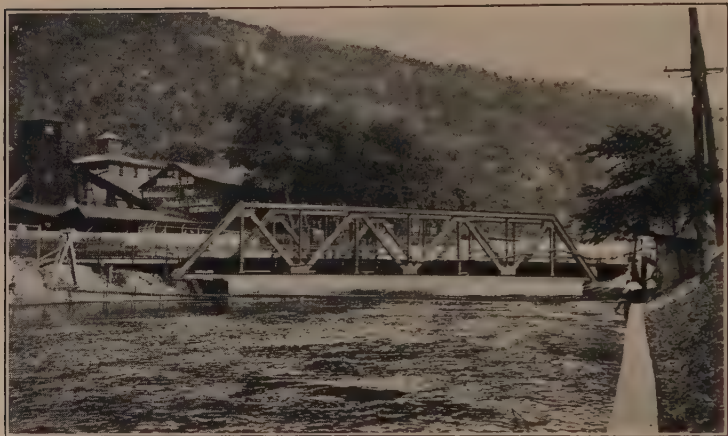


FIG. 11. — ELECTRODES AT LOWER END OF TEST SECTION OF CANAL,
BELLOWS FALLS, VT.



FIG. 12. — INJECTING SALT SOLUTION THROUGH CENTER PIPE
Turbulence indicated by rough water surface below pipes, in contrast
to glassy water surface above

SALT-VELOCITY MEASUREMENT

The salt-velocity tests were run over a length of canal 449 feet long. The electrodes at the lower end of this section, as shown in Fig. 11, were fifteen pairs of steel bars running to the bottom of the canal. At the upper end of the section ten small electrodes were attached at the jets. When making salt-velocity tests, the interval of time between the injection of the salt water at the upper end and the passing of the salt water at the lower end determined the velocity of the water.

In order to properly distribute the salt solution throughout the entire cross-section of the canal it was necessary to install a series of five



FIG. 13. — EQUIPMENT AND PIPE LAY-OUT FOR INJECTING
SALT SOLUTION

Operating the pop valve

vertical pipes, distributed across the channel and extending to the bottom of the canal, with horizontal branches leading at right angles to these verticals every four or five feet. Thus, a grillwork of pipes was located in the stream approximately 35 feet above the current meter section. This caused a turbulence in the water to a degree seldom experienced in any but extreme high-water measurements. This turbulence would undoubtedly have the effect of causing the meter to over-register, and to some extent would explain the greater discharge obtained by the current meter than by the salt-velocity method. Figs. 11 and 12 show turbulence caused by the salt-distribution pipes. Fig. 13 shows equipment and pipe layout for injecting salt solution.

CURRENT METER MEASUREMENT

Figs. 14 and 15 picture the equipment used in securing the current meter measurements of discharge. The boom and reel with indicator are pieces of equipment only recently developed by the United States Geological Survey. The measurements were made from the downstream handrail on the concrete arch bridge. Due to the excessive depth and high velocity it was necessary to use a 75-pound elliptical lead sounding



FIG. 14. — CURRENT METER AT DOWNSTREAM SIDE OF BRIDGE FROM WHICH SALT SOLUTION WAS INJECTED INTO CANAL, BELLOWS FALLS, VT.

weight in order that the meter could be held in the measuring section. A small improved Price current meter, rated with the same cable suspension as was used during the measurements, was placed at a distance of one foot above the bottom of the lead weight. The weight was handled by a reel which was equipped with an indicator for the purpose of determining the location of the meter in the water. The cross-section at the measuring section was obtained in still water by measuring down from points of known elevation on the bridge to the bottom of the canal. The depth of water during the measurement was obtained by measuring down

from these same points to the water surface and subtracting this distance from the difference in elevation between the points on the bridge and the bottom of the canal.

TABLE I.—RESULTS OF DETERMINATION OF DISCHARGE BY CURRENT METER AND SALT-VELOCITY METHOD AT BELLOWS FALLS, VT.

	Measurement No. 1	Measurement No. 2
Date	Aug. 16, 1929	Aug. 17, 1929
Measurement began	1.50 P.M.	10 A.M.
Measurement ended	3.31 P.M.	11.18 A.M.
Time of measurement	2 hrs. 41 min.	1 hr. 18 min.
Width	91.5 feet	91.5 feet
Area	1,870 sq. ft.	1,810 sq. ft.
Mean velocity	5.32 ft. per sec.	4.78 ft. per sec.
Average width of section	4.8 feet	4.8 feet
Average depth	20.4 feet	19.8 feet
Maximum depth	27.9 feet	27.5 feet
Average gross head	61.54 feet	—
Drop in head-race during measurement	0.3 foot	0.2 foot
Uncorrected discharge by current meter	8,950 sec. ft.	8,660 sec. ft.
Corrected discharge	9,896 sec. ft.	8,612 sec. ft.
Mean of two determinations of discharge by salt-velocity method, one at the beginning and one near the end of current meter measurement (tests Nos. 2 and 3)	9,780 sec. ft.	—
Determination of discharge by salt-velocity method taken near end of current meter measurement (test No. 5A)	—	8,587 sec. ft.

As in all regular stream gaging work, the .2 and .8 depth method was used to determine the mean velocity in each vertical, the points for the verticals being selected at five-foot intervals. When extreme accuracy is desired, it is customary to secure vertical velocity curves in order to determine corrections to be applied due to the use of the .2 and .8 depth method. Such a vertical velocity curve was secured at the mid-point of the measuring section by obtaining observations at every tenth of the depth. This curve indicated a mean velocity of 5.47 feet per second, while the mean of the velocity at the .2 and .8 depths was 5.50 feet per second. This indicated a correction to be applied to the mean velocity at this point of $-.55$ per cent. Applying this correction to the mean

velocity in each vertical the results in Table I are obtained. It should be noted that the current meter determination of discharge for the first measurement was 1.19 per cent greater and the second was .29 per cent greater than by the salt-velocity method. The mean difference for the two measurements is thus seen to be but .74 of 1 per cent, which indicates the degree of accuracy that should be considered possible for careful stream gaging work. Had not the artificial turbulence, caused by the

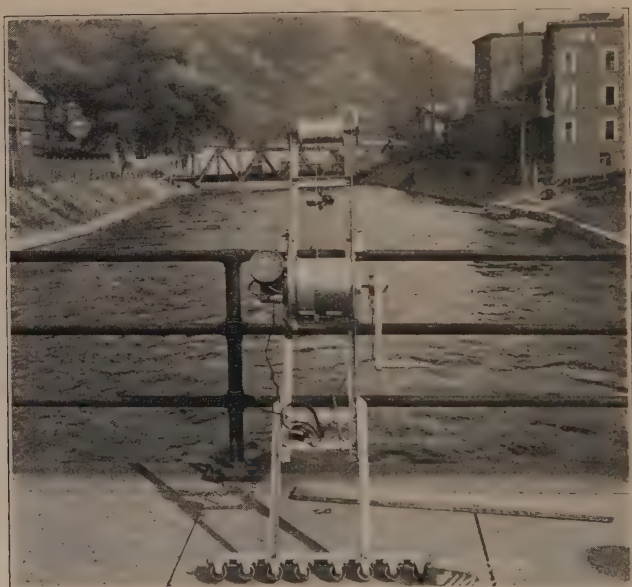


FIG. 15.—CANAL AT BEL LOWS FALLS, VT. CURRENT
METER EQUIPMENT AT MEASURING STATION

Stretch of canal used for salt-velocity tests

network of pipes immediately above the current meter section, been present, it is probable that the results of the current meter determinations of discharge would have more nearly checked the salt-velocity determinations of discharge.

Since it was impossible to ascertain to what degree of accuracy the salt-velocity determinations of discharge were made, but which were considered to be within 1 per cent of the true discharge, the conclusion is drawn that where conditions are favorable for accurate determinations of discharge by current meter the results are entirely dependable.

In the spring of 1927 the author had the opportunity to check current meter determination of discharge of the stream flowing through the

hydraulic laboratory of the Worcester Polytechnic Institute, located at Chaffinville, Mass., against the determination of the same flow as measured by a weir in the hydraulic laboratory. This weir had previously been rated to a high degree of accuracy by measuring the discharge volumetrically, by weight, and by the salt-velocity method. The current meter measurements were made in the stream at a point about 700 feet below the weir in a manner exactly similar to that usually followed by the United States Geological Survey. Table II gives the results of these measurements, and indicates the degree of accuracy obtained. It should be noted that the current meter measurements are smaller than the true discharge, as indicated by the weir, by an average of -1.16 per cent, rather than larger, as is usually expected.

TABLE II.—CURRENT METER DETERMINATION OF DISCHARGE, ALDEN LABORATORY, WORCESTER POLYTECHNIC INSTITUTE

HEAD		TRUE DISCHARGE BY WEIR		Total Discharge	Discharge by Current Meter	Per Cent Error
4' Weir	10' Weir	4' Weir	10' Weir			
0.253	0.000	1.74	0	1.74	1.75	+0.57
0.241	0.785	1.622	23.43	25.05	24.83	-0.88
0.179	0.934	1.049	30.42	31.469	30.83	-2.00

NEED FOR ADDITIONAL STATIONS

The availability of funds and the need for stream-flow data have determined the number and location of stream-gaging stations in New England. On Fig. 19 (page 200) is indicated the location of all stations in New England, with the exception of the State of Maine, which are being maintained by the United States Geological Survey, together with several stations the data for which is furnished for publication by other parties.

ESTIMATING STREAM FLOW

For streams on which no records of discharge are available, it is usually customary to estimate the discharge by comparison with records of flow on adjacent streams of similar characteristics. An exhaustive study leading to the determination of the probable error in this method of estimating stream flow on rivers for which no stream-flow data is

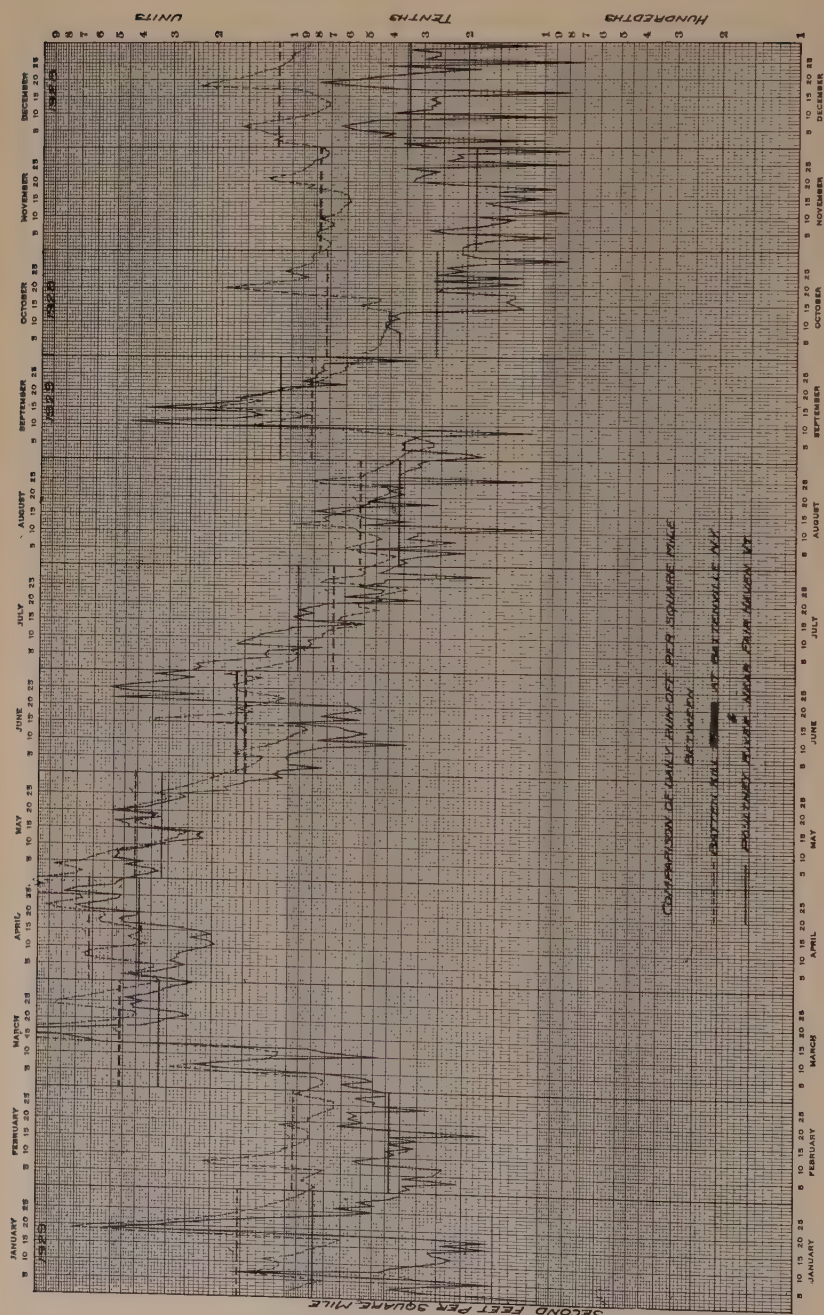


FIG. 16. — COMPARISON OF DAILY RUN-OFF PER SQUARE MILE

available has been made by John C. Prior* on streams in the State of Ohio. Some of his conclusions are as follows:

(1) In the present state of the science of hydrology there seems to be no adequate substitute for actual stream-flow measurements for obtaining annual runoff.

(2) Where actual flow records are available over a period of at least ten years, it is probably possible to compute the annual runoff in other years, where only rainfall and other physical data are available, with an extreme error for any year of less than 100 per cent, but errors of 50 per cent may not be uncommon and the mean annual error may amount to 25 per cent.

(3) On streams where no observed runoff records are available to be used as guides, the errors to be expected in applying annual runoff formulas and methods may easily exceed those suggested in the preceding paragraph.

(4) The runoff characteristics of one stream may be entirely different from those of another, even though they are situated side by side.

(5) The general slope of the drainage basin, which includes the character of the soil and culture, will have a pronounced effect upon the amount of water appearing as runoff.

(6) Calculated amounts of runoff for short periods, say a month or less, will be subject to such large errors as to make them valueless, except for very rough approximations.

In the year 1929 the author attempted to compare records from two stations near the western border of the State of Vermont with results as shown in Fig. 16, indicating that a prohibitive error may be obtained by estimating the discharge of one river from the records of discharge of another. The study was made for the six-months period ending March 31, 1929, when but six months' record from the Poultney River was available. The Batten Kill, with a drainage area of 397 square miles, would ordinarily be expected to show a smaller yield in discharge per square mile than the Poultney River, with a drainage area of 187 square miles. The yield of the Batten Kill, however, was several times greater than the Poultney River, the largest difference being in November, when it was 400 per cent greater, the average for the six months being nearly 100 per cent greater. The difference in yield of the two rivers is largely explained by the difference of precipitation on the watersheds. If accurate knowledge is to be had as to the flow of streams in New England on which no stations are located it will be necessary to

* "Runoff Formulas and Methods applied to Selected Ohio Streams," by John C. Prior, published by Engineering Experiment Station, University of Ohio, Bulletin No. 49.

establish many more stream-gaging stations. It has been estimated that a total of 108 stations should be operated in the States of Massachusetts, Vermont and New Hampshire.

USE OF DATA

One of the most common uses of stream-flow data is the preparation of the mass curve of run-off. It is convenient, especially for showing the

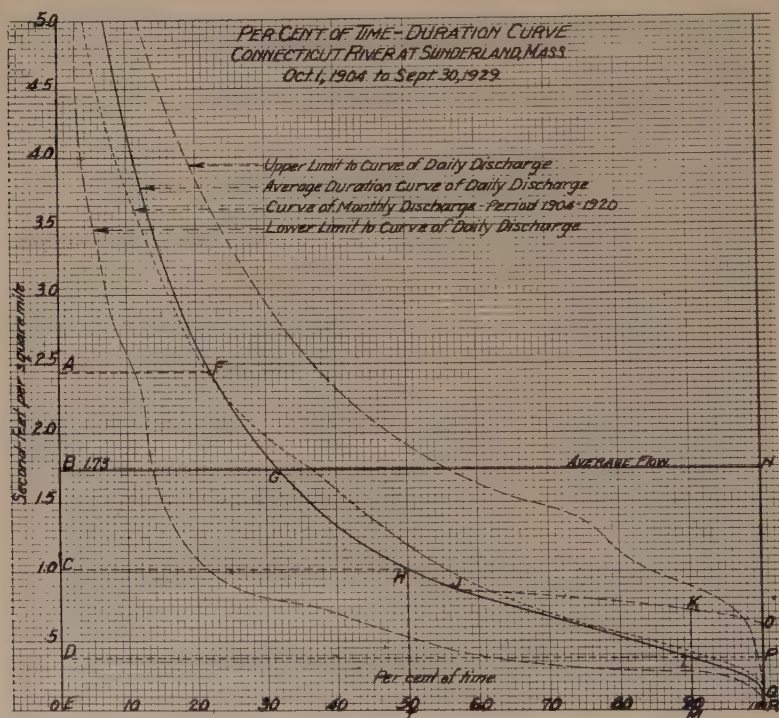


FIG. 17. — PER CENT OF TIME-DURATION CURVE, CONNECTICUT RIVER, SUNDERLAND, MASS.

allowable rate of draft which depends upon the accumulative flow of the stream. It also indicates the amount of storage necessary to allow such a draft. Another useful study of stream-flow data is the preparation of a hydrograph covering the years of record. This shows at a glance the high and low periods of each year, and indicates the probable flow of the river for any period of the year, which is helpful in determining heights of cofferdams and capacity of spillways during construction. By balancing the areas below a certain discharge with areas above this

discharge it is possible to determine from the hydrograph the dependable flow capable of being developed by use of storage.

DURATION CURVE

The most useful study of stream flow, however, is the duration curve. The Sectional Committee of the American Engineering Stand-

CONNECTICUT RIVER AT SLINDERLAND, MASS. DEFICIENCY TABLE 1928-29.

Sec. Ft. Disch. per Sq. mi. average	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug.	Sept	Sum	Total Defic- iency	Total Dura- tion	% Dura- tion
0.05 400																
.1 800																
.15 1200															365	100.0
.2 1600												II ②	2	2	363	995
.3 2400										II ②	I ⑦	IV ⑤	8	10	355	973
.4 3200										III ③	III ③	III ⑦	18	28	337	923
.5 4000 I ①										II ②	III ③	III ⑦	17	45	320	877
.6 4800 II ②		I ①								III ⑤	III ⑦	III ⑦	5	23	68	297 814
.7 5600 III ④	II ②	II ③	III ③		II ②				I ①	III ④	II ③	I ①	20	88	277	759
.8 6400 III ⑤	III ⑤	III ⑤	III ⑤	III ④	III ④	III ④			II ②	III ⑦	I ①	II ③	42	130	235	644
.9 7200 III ③	III ③	III ④	III ④	III ③	III ③	III ③	III ③		III ④	II ②			37	167	198	542
.10 8000 III ③	III ③	III ③	III ②	II ②	II ②	II ②	II ②		III ④				18	185	180	493
.11 8800 I ①	I ①	I ①	II ②	III ③		I ①			II ②	I ①		I ①	14	199	166	455
.12 9600 I ①	III ③	III ③	III ③	III ③	I ①	I ①			III ③	III ③			22	221	144	395
.13 10400									III ④				11	232	133	364
.14 11200 III ③		II ②			I ①				II ②	I ①			9	241	124	340
.15 12000	II ②		III ③		II ③				III ⑥				14	255	110	301
.16 12800 I ①			I ①						I ①				3	258	107	293
.175 14000 II ②	I ①	II ②		II ②	II ②		I ①	I ①					9	269	98	268
.19 15200 III ⑤	I ①	II ②							I ①				9	276	89	244
20.5 16400			I ①	I ①									2	278	87	238
22.5 18000	II ②	I ①	III ③				I ①		I ①				7	285	80	219
2.5 20000	I ①		I ①		I ①		II ②						5	290	75	205
2.75 22000			I ①				II ②						3	293	72	197
3.00 24000							I ①						1	294	71	195
3.5 28000							III ⑤						5	299	66	181
4.0 32000					II ②	III ④	III ③						9	308	57	156
4.5 36000					III ③	III ③	III ⑦	III ⑤					15	323	42	115
5.0 40000					III ⑤	II ②	I ①						8	331	34	93
7.0 56000					III ④	III ④	III ④	III ④					26	357	8	22
10.0 80000					III ③	III ③	III ②						8	365	0	00
	31	30	31	31	28	31	30	31	30	31	31	30	365			

TABLE III

ards Committee is unanimous with regard to the use of the duration curve as a basis for the determination of rates of flow to be used in the rules for rating of rivers. Some of the reasons for its popularity are: (1) It is in widespread use among engineers in many countries. (2) Rates of flow based on the curve are easily defined. (3) Defined rates of flow can easily be checked by computations made independently.

(4) It presents a generalized picture of the flow and the relation of flows of various magnitude to the duration of time. The preparation of the duration curve is illustrated by Tables III and IV.

Fig. 17 shows the duration curve for the Connecticut River at

*Connecticut River at Sunderland, Mass. Percent of time Duration.
Oct. 1, 1904 to Sept. 30, 1929. Drainage Area, 8000 sq. mi.*

Sec. ft. per sq. mi.	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	Sum	Aver- age	Max-Min imum
0.05	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	2500.0	100.0	100.0
.1	100.0	99.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	2499.9	100.0	99.7
.15	99.7	99.5	100.0	99.7	99.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	2493.9	99.8	98.4
.2	99.7	97.3	98.9	99.2	98.6	100.0	99.7	99.5	97.3	98.9	99.2	99.7	99.5	2474.6	99.0	97.0
.3	99.9	90.4	96.2	98.1	97.2	97.8	99.5	97.3	93.5	94.1	99.7	97.5	95.6	2411.1	97.7	95.6
.4	92.9	78.9	91.8	93.4	95.6	95.0	99.2	92.3	87.3	99.2	98.4	99.2	98.4	2318.8	97.3	95.6
.5	88.5	68.8	88.0	87.7	92.6	91.2	98.9	87.7	81.8	98.9	98.4	98.9	98.4	2244.8	97.3	95.6
.6	78.6	59.2	81.2	78.4	85.8	79.7	98.6	81.4	73.5	98.6	98.4	98.6	98.4	2182.8	97.3	95.6
.7	73.2	48.8	77.6	68.8	79.2	74.0	96.8	75.9	68.0	96.8	98.4	98.4	98.4	2044.8	97.3	95.6
.8	67.9	41.9	69.2	60.6	74.5	68.0	92.4	64.4	61.2	92.4	98.4	98.4	98.4	1931.0	97.3	95.6
.9	59.5	33.4	61.8	54.3	70.4	55.6	88.5	54.2	55.1	88.5	98.4	98.4	98.4	1824.6	97.3	95.6
1.0	53.2	28.5	53.6	49.9	64.7	48.0	85.8	49.3	50.6	85.8	98.4	98.4	98.4	1766.0	97.3	95.6
1.1	47.7	26.3	48.2	44.7	60.3	45.2	81.2	45.5	47.1	81.2	98.4	98.4	98.4	1767.7	97.3	95.6
1.2	44.1	24.9	44.8	41.1	54.0	42.0	78.7	39.5	43.4	78.7	98.4	98.4	98.4	1685.3	97.3	95.6
1.3	41.6	23.8	43.5	39.8	48.0	38.9	77.4	36.4	41.1	77.4	98.4	98.4	98.4	1627.8	97.3	95.6
1.4	39.5	22.7	41.3	38.7	42.0	34.3	74.0	34.0	38.6	74.0	98.4	98.4	98.4	1565.0	97.3	95.6
1.5	37.5	21.9	40.2	37.3	42.0	32.1	66.7	30.1	36.5	66.7	98.4	98.4	98.4	1512.6	97.3	95.6
1.6	36.2	21.1	38.3	36.2	38.7	28.5	62.3	29.3	33.9	62.3	98.4	98.4	98.4	1469.3	97.3	95.6
1.75	34.5	20.3	35.3	35.1	34.6	26.8	54.4	26.8	31.6	54.4	98.4	98.4	98.4	1389.1	97.3	95.6
1.9	32.6	18.1	31.5	32.4	30.2	24.1	50.3	24.4	28.8	50.3	98.4	98.4	98.4	1320.7	97.3	95.6
2.05	31.0	17.5	28.7	28.8	27.4	21.1	46.5	23.8	26.9	46.5	98.4	98.4	98.4	1271.6	97.3	95.6
2.25	28.5	16.7	26.8	24.9	23.6	18.1	41.6	21.9	24.3	41.6	98.4	98.4	98.4	1209.3	97.3	95.6
2.5	26.6	15.3	24.1	20.8	21.1	12.3	35.0	20.5	21.2	35.0	98.4	98.4	98.4	1129.6	97.3	95.6
2.75	24.9	14.0	23.0	18.1	17.3	8.5	32.5	19.7	18.9	32.5	98.4	98.4	98.4	1071.7	97.3	95.6
3.0	21.9	13.2	21.1	15.9	15.9	7.1	29.8	19.5	17.1	29.8	98.4	98.4	98.4	1027.8	97.3	95.6
3.5	18.1	10.1	19.7	10.7	12.1	5.2	23.5	18.1	13.6	23.5	98.4	98.4	98.4	937.9	97.3	95.6
4.0	15.6	8.8	17.8	7.4	9.9	3.6	18.9	15.6	11.1	18.9	98.4	98.4	98.4	876.5	97.3	95.6
4.5	13.2	7.7	14.5	5.2	7.7	2.7	12.3	11.5	8.3	14.5	98.4	98.4	98.4	807.1	97.3	95.6
5.0	11.0	7.1	11.8	3.8	6.0	2.7	6.6	9.3	6.9	11.8	98.4	98.4	98.4	733.2	97.3	95.6
7.0	4.4	3.0	1.4	1.9	2.7	1.4	3.6	2.2	2.4	7.1	98.4	98.4	98.4	594.4	97.3	95.6
10.0	1.4	.8	.0	.5	.3	.0	1.1	.0	.4	1.4	98.4	98.4	98.4	93.3	97.3	95.6
15.0	.0	.0	.0	.0	.0	.0	.5	.0	.5	.0	98.4	98.4	98.4	.5	97.3	95.6

TABLE IV

Sunderland, Mass., for a twenty-five-year period ending September 30, 1929.

As a matter of convenience and simplicity it has been found desirable to make the tabulation for "days' deficiency", and then to transform "days' deficiency" into "days' duration" and "per cent of time

duration", although many engineers prefer to make direct computations of "days' duration".

Table III is the working sheet on which the tabulations for one year are made. The first column gives the unit values (scale) in second-feet per square mile, which is used for all stations. The second column is the discharge at the individual station, obtained by multiplying the scale in second-feet per square mile by the drainage area for that station. For each month mark the proper position for each day, beginning the first day of the month and taking the days in order until the end of the month, making a mark in the proper place for each day. It should be noted that daily discharge of the same amount as the tabular figure is listed for the next higher figure in preparing the deficiency table; that is, a discharge of 2,400 second-feet would be listed as a deficiency for 3,200 second-feet in this table. The arabic figures enclosed by circles are for convenience in making the horizontal addition along each line for the "Sum" column. The "Total deficiency" column is the cumulative summation of the "Sum" column, and by subtraction from the number of days in a year the "Total duration" column is obtained. The "Per cent duration" column represents the summary for the year, and is transferred to its proper place on Table IV.

Table IV contains the individual yearly duration tables for the entire period of record, each of which may be plotted if desired. The last three columns on this sheet, which are headed "Average", "Maximum", and "Minimum", are obtained by taking the average, the highest, and the lowest of the figures on each horizontal line. The so-called "Maximum" and "Minimum" curves, which are plotted as "Upper limit" and "Lower limit" on Fig. 17, are the enveloping curves between which all duration curves would lie if each year's curve was plotted separately.

The "Curve of monthly discharge" on Fig. 17 is obtained by using values of monthly mean discharge instead of daily discharge. The curve of monthly discharge is always higher than the curve of daily discharge for values which are critical in water-power studies, but on account of ease of computation it is used by many engineers. Note that in the example shown on Fig. 17, the value indicated by the monthly duration curve for 40 per cent of time is 20 per cent higher than the true value as shown by the daily duration curve, due to the fact that the monthly mean has included a considerable range of stage which in the daily duration curve is distributed in order of magnitude.

Clemens Herschel, past president, American Society of Civil Engineers, has made the following statement in regard to duration curves:

If the daily discharges of a river at a certain point be plotted for the three hundred and sixty-five days of the year, in the order of their magnitude (not consecutively in the order of the date of their occurrence), a perfectly smooth curve showing the year's discharge will be produced. Take fifteen or twenty such years, if the records avail, and three such curves may be produced; one of average flow, another enveloping all the minima flows, and a third enveloping the maxima flows. And for a period of that length the discharge of that river at that point has been portrayed practically for all time. Nothing, or little more, is needed in its hydrographic study for the uses of a constructing engineer. (Journal of Boston Society of Civil Engineers, Vol. 3, page 305.)

Duration curves are useful in determining the amount of storage or auxiliary power needed to supply a constant demand. Fig. 17 illustrates some of the uses of such a curve.

F G H J L Q = lower part of duration curve for period of record.

J K O = assumed lower part of curve with regulation.

H I = 50 per cent time flow.

L M = 90 per cent time flow, natural.

K M = 90 per cent time flow, with assumed regulation.

A E = flow that will be used when ultimate installation is made as proposed.

B E = mean flow for period of record = theoretical flow with complete regulation.

Assuming that power instead of flow is represented on the vertical axis, 100 per cent load and efficiency factors, and installation to point of 50 per cent time flow:

Area D L Q R E = reliable power in kilowatt hours obtainable in most years. This quantity may be computed with an error of less than 3 per cent by multiplying the 90 per cent time power by 8,760 (hours in a year).

Area C H L D = secondary power in kilowatt hours obtainable in most years. This quantity may be computed by multiplying the difference between the 90 per cent and the 50 per cent time power by 4,380, and adding thereto the product of one-half the difference between the 90 per cent time power and the 50 per cent time power by 3,504. The error in this computation will be only a few per cent, represented by the area between the curved line H J L and the straight line H L.

K M x 8760 = power output obtainable with storage in most years.

K L x 8760 = increase in output of reliable power resulting from storage obtainable in most years.

When the duration curve is plotted so that one inch vertically represents 0.5 second-feet per square mile, and one inch horizontally represents 10 per cent of one year, one square inch area will represent 1.58 million cubic feet per square mile of drainage area, or for each foot

of fall will be equivalent to 49.7 theoretical horsepower hours per square mile of drainage area. By plotting on the curve a horizontal line representing the desired plant capacity, and finding the square inches below this line and above the duration curve, we can find the number of million cubic feet of storage needed yearly by multiplying the square inches by

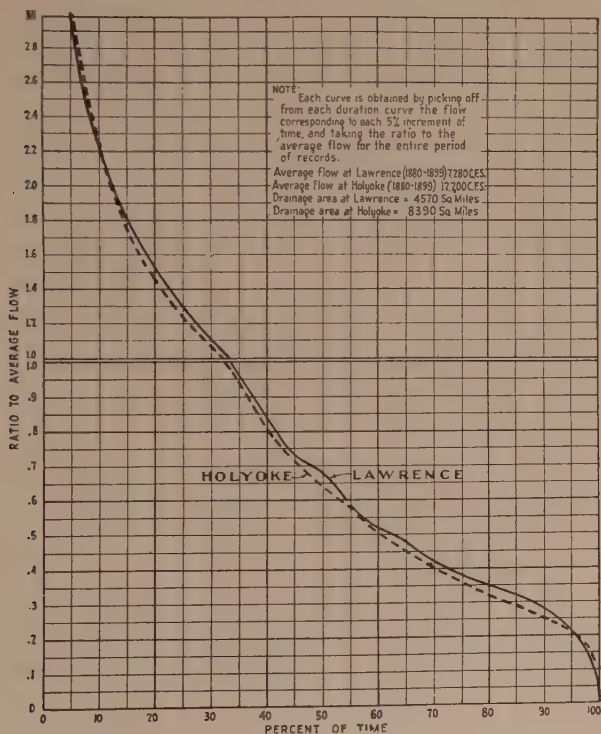


FIG. 18. — COMPARISON OF RUN-OFF, CONNECTICUT AND MERRIMACK RIVERS, AT HOLYOKE AND LAWRENCE

Period, October, 1880, to September, 1899

1.58 by the number of square miles of drainage area. Or, if the deficiency is to be made up by steam power, the amount of this power is found by multiplying the number of square inches by 49.7 by the drainage area, times head utilized, times the overall efficiency of water power plant.

In many sections of the country the greatest demand for electrical energy occurs during the period of the year when the supply of water is more than during the dry period. Should the size of the power plant be

controlled by the average duration curve, which includes all the low flows of the year, it will be smaller than necessary, since the demand for power will not be so great during the period of low flow. It is, therefore, necessary to compare the variations in the load curve to the variations in runoff in order to find the proper size for the development. The variation in runoff is best determined by preparing for each month a duration table covering the whole period of record. These tables can be prepared at the time of the computation of the yearly duration table with but little additional work.

Duration curves may be plotted using "per cent of average flow" and "per cent of time" as ordinates. When plotted in this form the curves are adapted to show variations in characteristics of different rivers, and are used by some engineers as a means of estimating probable distribution of flow, by order of magnitude, for a given or estimated average flow. By comparing such curves prepared for various rivers over the same period of time it has been found that the characteristics of flow for rivers in widely separated localities and large differences in drainage areas are greatly similar. This makes it possible to supplement a short record on one stream by a long period of record on another stream which has a similar distribution of flow. An illustration of such a comparison is shown in Fig. 18. A description of this use of the duration curve is published on page 171 of the "Report of the Committee on Runoff."*

Another illustration of the use of this method is made in the "Discussion," by Dana M. Wood.†

The following tabulation of monthly mean discharge in second-feet per square mile is a summary of stream-flow data for practically all river-gaging stations in New England except those in the State of Maine. They include not only data for stations operated by the United States Geological Survey but also for stations operated by other organizations or individuals, for which acknowledgment has been given. At many stations the data were fragmentary or covered a period of less than two years. In such cases the information is omitted.

GAGING STATIONS

Androscoggin River Basin

1. Androscoggin River at Berlin, N. H.

Saco River Basin

2. Saco River at Center Conway, N. H.

* Journal of Boston Society of Civil Engineers, Vol. 9, No. 8, October, 1922.

† "Discussion on Rainfall and Runoff Studies," by Dana M. Wood, Transactions of the American Society of Civil Engineers, Vol. LXXXV, 1922.

Salmon Falls River Basin

3. Salmon Falls River at East Rochester, N. H.

Merrimack River Basin

4. Pemigewasset River at Plymouth, N. H.
5. Merrimack River at Franklin Junction, N. H.
6. Merrimack River at Manchester, N. H.
7. Merrimack River at Lawrence, Mass.
8. East Branch of Pemigewasset River at Lincoln, N. H.
9. Bakers River at Rumney, N. H.
10. Smith River near Bristol, N. H.
11. Contoocook River at Penacook, N. H.
12. Nubanusit Brook near Peterboro, N. H.
13. North Branch of Contoocook River near Antrim, N. H.
14. Blackwater River near Contoocook, N. H.
15. Suncook River at North Chichester, N. H.
16. Souhegan River at Merrimack, N. H.
17. South Branch of Nashua River at Clinton, Mass.
18. Lake Cochituate basin at Cochituate, Mass.
19. Sudbury River at Framingham Center, Mass.

Taunton River Basin

20. Wading River near Norton, Mass.

Providence River Basin

21. Blackstone River at Worcester, Mass.
22. Blackstone River at Woonsocket, R. I.

Thames River Basin

23. Quinebaug River at Putnam, Conn.
24. Quinebaug River at Jewett City, Conn.
25. Shetucket River at South Windham, Conn.

Connecticut River Basin

26. Connecticut River at First Connecticut Lake, near Pittsburg, N. H.
27. Connecticut River at Waterford, Vt.
28. Connecticut River at South Newbury, Vt.
29. Connecticut River at White River Junction, Vt.
30. Connecticut River at Vernon, Vt.
31. Connecticut River at Turners Falls, Mass.
32. Connecticut River at Montague City, Mass.
33. Connecticut River at Sunderland, Mass.
34. Connecticut River at Thompsonville, Conn.
35. Passumpsic River near Passumpsic, Vt.
36. Moose River at St. Johnsbury, Vt.
37. White River at West Hartford, Vt.
38. Mascoma River at Mascoma, N. H.
39. Ottauquechee River at Woodstock, Vt.
40. Sugar River at West Claremont, N. H.

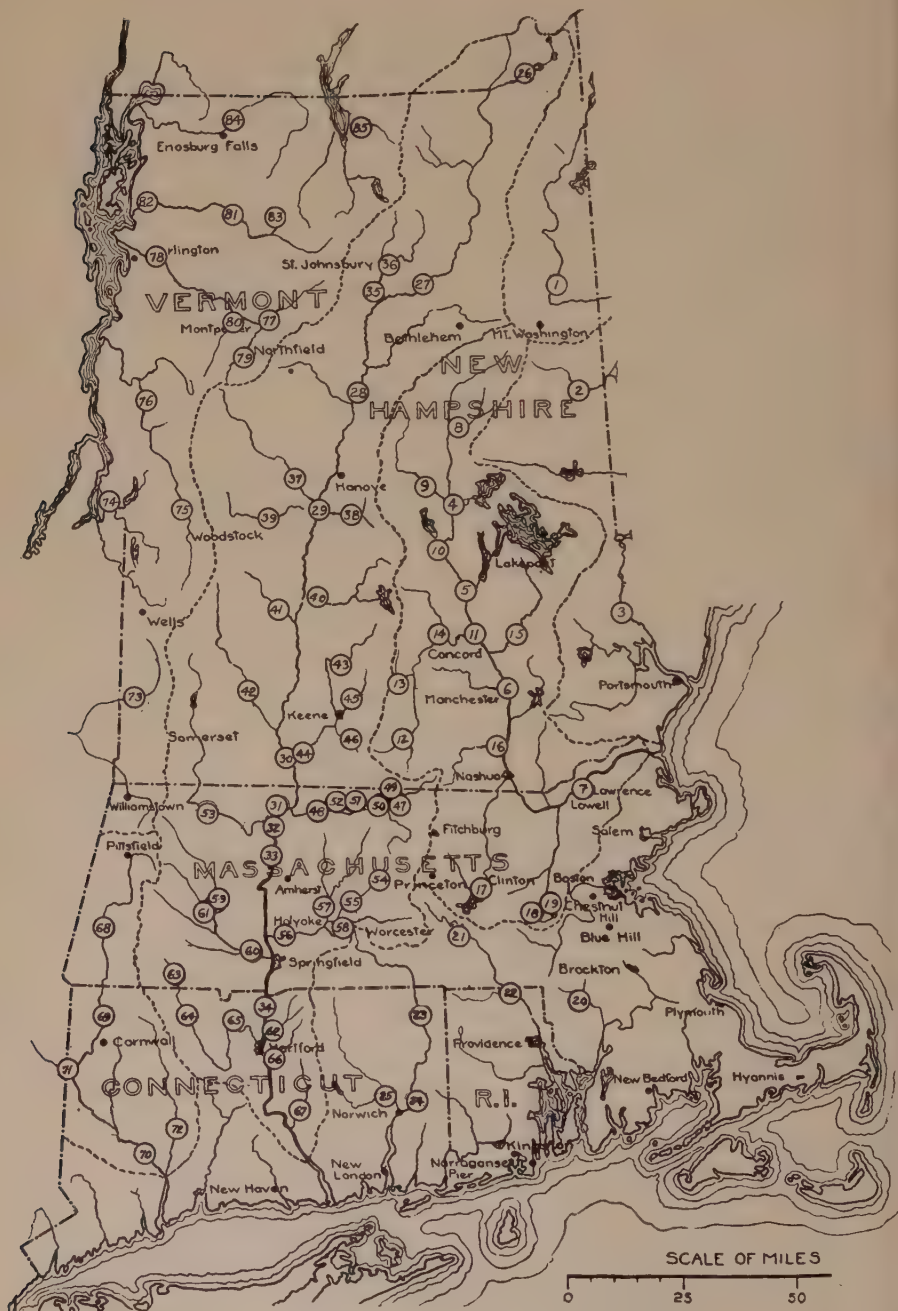


FIG. 19. — LOCATION OF STREAM GAGING STATIONS

41. Black River at North Springfield, Vt.
42. West River at Newfane, Vt.
43. Ashuelot River near Gilsun, N. H.
44. Ashuelot River at Hinsdale, N. H.
45. Otter Brook near Keene, N. H.
46. South Branch of Ashuelot River near Marlboro, N. H.
47. Millers River near Winchendon, Mass.
48. Millers River at Erving, Mass.
49. Sip Pond Brook near Winchendon, Mass.
50. Priest Brook near Winchendon, Mass.
51. East Branch of Tully River near Athol, Mass.
52. Moss Brook at Wendell Depot, Mass.
53. Deerfield River at Charlemont, Mass.
54. Ware River at Cold Brook, Mass.
55. Ware River at Gibbs Crossing, Mass.
56. Chicopee River at Bircham Bend, Mass.
57. Swift River at West Ware, Mass.
58. Quaboag River at West Brimfield, Mass.
59. Westfield River at Knightville, Mass.
60. Westfield River near Westfield, Mass.
61. Middle Branch of Westfield River at Goss Heights, Mass.
62. Scantic River at Broad Brook, Conn.
63. Farmington River at New Boston, Mass.
64. Farmington River at Riverton, Conn.
65. Farmington River at Tariffville, Conn.
66. Hockanum River at East Hartford, Conn.
67. Salmon River near East Hampton, Conn.

• *Housatonic River Basin*

68. Housatonic River near Great Barrington, Mass.
69. Housatonic River at Falls Village, Conn.
70. Housatonic River at Stevenson, Conn.
71. Tenmile River near Gaylordsville, Conn.
72. Naugatuck River near Naugatuck, Conn.
73. Batten Kill at Arlington, Vt.

St. Lawrence River Basin

74. Poultney River near Fair Haven, Vt.
75. Otter Creek at Center Rutland, Vt.
76. Otter Creek at Middlebury, Vt.
77. Winooski River at Montpelier, Vt.
78. Winooski River at Essex Junction, Vt.
79. Dog River at Northfield, Vt.
80. Mad River at Moretown, Vt.
81. Lamoille River at Johnson, Vt.
82. Lamoille River at Milton, Vt.
83. Green River at Garfield, Vt.
84. Missisquoi River at Richford, Vt.
85. Clyde River at Newport, Vt.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Androscoggin River at Errol Dam, N. H.

(Drainage area, 1,095 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1905	—	—	—	1.44	1.14	.69	1.36	3.29	1.99	1.63	1.27	1.17	—
1905-06	1.23	1.26	1.06	1.06	1.03	.84	1.27	4.62	3.32	1.42	1.21	1.13	1.63
1906-07	1.21	.91	.86	1.00	.97	1.00	1.12	4.54	2.13	1.72	1.41	1.35	1.52
1907-08	1.34	3.42	1.61	1.46	1.60	1.77	2.18	5.41	2.81	1.27	1.02	1.24	2.10
1908-09	1.20	.95	.77	.69	.70	.80	3.02	5.67	2.89	1.29	1.25	1.12	1.70
1909-10	.859	.977	.986	1.02	1.08	1.05	3.10	2.56	2.52	1.11	1.02	1.08	1.44
1910-11	.895	.942	1.09	.789	.656	.654	1.05	1.95	.697	.977	.888	.824	.954
1911-12	.889	.825	1.09	1.51	1.63	1.43	1.47	1.99	3.03	1.53	1.31	1.37	1.50
1912-13	1.29	1.32	1.32	1.86	1.87	2.55	4.33	2.79	2.37	1.78	1.86	1.54	2.07
1913-14	1.19	1.11	1.63	1.68	1.68	1.51	1.05	2.13	1.40	1.42	1.52	1.61	1.50
1914-15	1.52	1.49	1.38	1.41	1.29	1.11	.838	1.00	1.20	.738	.767	1.32	1.17
1915-16	1.43	1.47	1.52	1.35	1.37	1.48	1.30	1.95	4.03	1.77	1.61	1.63	1.74
1916-17	1.53	1.53	1.44	1.77	2.02	2.03	1.40	1.77	6.51	2.27	1.81	1.69	2.14
1917-18	1.62	1.76	1.95	1.83	1.84	1.93	1.82	1.36	1.35	1.63	1.80	1.27	1.68
1918-19	1.25	1.84	1.84	2.13	1.68	1.51	1.87	3.67	2.05	1.82	1.71	1.54	1.91
1919-20	1.22	1.08	1.59	1.74	1.82	1.53	1.42	2.74	1.93	1.44	1.54	1.55	1.63
1920-21	1.48	1.47	1.45	1.83	1.96	1.82	2.16	1.85	1.50	1.22	1.17	1.11	1.58

NOTE. — Not corrected for effect of storage. Records furnished by Walter H. Sawyer, Agent, Union Water Power Company.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Androscoggin River at Berlin, N. H.

(Drainage area, 1,350 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1913-14	1.31	1.36	1.42	1.36	1.26	1.44	2.39	3.62	1.34	1.33	1.29	1.30	1.62
1914-15	1.28	1.26	1.21	1.17	1.18	1.06	1.70	1.44	1.14	1.30	1.21	1.25	1.27
1915-16	1.29	1.30	1.38	1.36	1.33	1.37	2.38	2.78	4.94	2.20	1.75	1.51	1.97
1916-17	1.48	1.56	1.61	1.53	1.67	1.81	2.33	2.87	7.85	2.12	1.50	1.52	2.31
1917-18	1.62	1.81	1.64	1.64	1.50	1.56	2.16	1.79	1.45	1.43	1.40	1.24	1.61
1918-19	1.75	1.96	1.65	1.58	1.39	1.46	2.31	3.80	1.67	1.45	1.31	1.34	1.81
1919-20	1.31	1.39	1.41	1.35	1.40	1.44	2.19	2.50	1.76	1.41	1.41	1.44	1.59
1920-21	1.48	1.57	1.67	1.56	1.56	2.50	1.99	1.47	1.28	1.19	1.19	1.19	1.56

NOTE. — Not corrected for effect of storage. Records furnished by Walter H. Sawyer, Agent, Union Water Power Company.

STREAM-FLOW DATA — ITS COLLECTION AND USE

203

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Saco River near Center Conway, N. H.

(Drainage area, 385 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1903	—	—	—	—	—	—	—	—	—	—	—	.704	—
1903-04	1.49	—	—	—	—	—	7.35	9.61	1.24	.675	.740	1.12	—
1904-05	2.03	—	—	—	—	—	5.25	3.14	2.13	2.11	2.01	3.97	—
1905-06	1.68	1.51	—	—	—	—	5.07	5.56	3.43	1.35	.678	.408	—
1906-07	1.05	.940	—	—	—	2.08	5.25	6.83	1.95	1.15	.629	1.44	—
1907-08	3.35	6.47	3.19	1.36	1.90	2.28	5.95	6.05	1.70	.950	1.45	.452	2.91
1908-09	.481	.548	.434	.883	.909	1.82	9.06	6.70	1.79	.694	.416	.784	2.04
1909-10	.847	.849	.712	.753	.753	3.82	7.27	2.78	2.01	.587	.987	.647	1.83
1910-11	.473	.912	.512	.922	.571	.649	4.42	4.39	1.41	.530	.499	.574	1.32
1911-12	1.36	1.43	2.01	—	—	—	5.51	4.03	—	—	—	—	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Pemigewasset River at Plymouth, N. H.

(Drainage area, 615 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1903-04	.802	.665	1.48	1.01	.857	4.60	6.83	7.50	.873	.558	.985	1.79	2.34
1904-05	2.57	.935	.564	1.00	.527	3.67	5.30	2.67	1.90	1.38	1.05	3.79	2.11
1905-06	1.07	.979	1.67	2.11	1.41	.914	5.53	5.89	2.67	1.00	.634	.395	2.03
1906-07	.813	.820	.668	.763	.571	1.97	5.35	5.64	1.61	.998	.507	1.31	1.76
1907-08	3.66	4.49	3.02	1.40	2.00	2.59	6.24	6.28	1.14	.850	1.42	.345	2.78
1908-09	.389	.546	.502	1.10	1.30	1.79	9.48	5.72	1.74	.603	.433	.793	2.03
1909-10	.766	.802	.764	1.57	.807	4.81	6.33	2.52	2.23	.618	1.27	1.08	1.97
1910-11	.685	1.10	.782	1.56	.611	1.21	6.83	3.76	1.13	.424	.551	.912	1.63
1911-12	2.15	1.74	2.26	1.02	.498	2.15	8.29	4.65	1.67	.408	1.11	.758	2.23
1912-13	2.24	2.60	1.80	3.20	1.09	7.89	4.54	2.41	1.01	.507	.341	.610	2.37
1913-14	1.93	2.16	1.15	.980	.979	4.84	7.72	4.47	.805	.546	.472	.408	2.21
1914-15	.330	.576	.636	1.72	4.21	4.16	4.42	2.00	.891	3.33	2.21	.870	2.10
1915-16	.868	1.10	1.84	2.80	2.52	2.24	6.29	4.44	4.26	2.13	.954	1.00	2.53
1916-17	1.07	1.46	1.69	1.04	.701	2.76	6.41	4.85	6.31	1.08	.735	5.43	2.39
1917-18	1.50	1.33	.610	.450	.751	2.76	6.11	3.15	1.42	.834	.868	2.10	1.82
1918-19	2.67	2.33	2.54	1.69	.787	4.59	4.52	4.98	1.05	.402	.252	1.40	2.28
1919-20	2.34	3.85	2.02	.445	.332	4.50	8.76	5.66	1.58	.842	.649	1.02	2.67
1920-21	1.93	1.71	3.85	1.11	.701	6.72	5.17	1.31	.460	.532	.649	.384	2.05
1921-22	.763	1.95	2.15	.924	.724	3.97	8.05	4.18	5.61	2.34	.805	.589	2.67
1922-23	.605	.545	.431	1.27	.507	1.06	9.72	4.78	1.12	.260	.180	.174	1.72
1923-24	.787	1.82	3.72	2.81	.761	1.08	5.84	6.54	1.27	.644	.525	2.60	2.37
1924-25	1.82	1.95	1.72	.532	3.84	4.60	4.81	2.81	1.36	2.41	.917	1.26	2.33
1925-26	2.54	3.74	2.34	1.05	.813	.847	4.42	5.80	1.77	.992	.387	.468	2.10
1926-27	1.34	3.50	1.01	.695	.611	2.83	3.71	2.73	1.27	1.42	.774	.634	1.71
1927-28	2.05	7.45	3.24	1.85	1.25	2.39	6.18	5.45	2.62	1.59	1.79	1.04	3.07
1928-29	.872	1.37	.995	1.19	.673	3.98	7.30	6.31	1.40	.763	.405	.517	2.15

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Merrimack River at Franklin Junction, N. H.

(Drainage area, 1,460 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1903	—	—	—	—	—	—	—	—	—	—	1.01	.692	—
1903-04	.925	.795	.966	—	—	—	5.36	5.31	1.28	.822	1.13	1.34	—
1904-05	—	.897	—	—	—	—	4.11	2.04	1.64	1.25	1.09	3.22	—
1905-06	1.23	1.21	1.70	2.02	1.36	1.25	4.53	4.06	2.88	1.47	1.03	.744	1.96
1906-07	1.11	1.01	1.08	1.25	.925	1.68	3.96	3.71	1.69	1.12	.774	1.18	1.62
1907-08	2.86	3.73	2.34	1.36	2.01	2.51	4.03	4.39	1.50	1.00	1.49	.663	2.32
1908-09	.623	.740	.647	1.07	1.61	1.67	6.85	3.34	1.49	.849	.795	1.01	1.72
1909-10	1.08	.747	.719	1.41	1.15	3.72	3.98	2.36	1.97	.904	1.01	.801	1.66
1910-11	.760	1.05	.699	.973	.685	1.08	4.87	2.77	1.09	.661	.747	1.01	1.37
1911-12	1.88	1.71	1.82	1.23	1.27	2.16	5.53	3.26	1.86	.781	1.40	1.21	2.01
1912-13	2.12	2.52	1.78	2.11	1.40	4.80	2.97	2.16	1.54	.753	.760	.911	1.99
1913-14	1.48	1.85	1.27	1.03	1.08	2.82	6.05	3.38	1.28	1.04	.952	.870	1.92
1914-15	.788	.877	.740	1.35	2.42	1.70	2.84	1.60	.890	3.02	2.14	1.07	1.62
1915-16	1.17	1.22	1.58	1.52	1.94	1.77	4.68	3.61	4.76	2.33	1.29	1.15	2.25
1916-17	1.14	1.22	1.95	1.06	.863	2.35	4.61	3.47	4.99	1.49	.986	1.01	2.10
1917-18	1.52	1.35	.753	.637	.842	1.82	4.38	2.22	1.29	.966	1.02	1.76	1.55
1918-19	1.84	1.77	1.72	1.49	.863	3.61	3.51	4.08	1.47	.849	.726	1.23	1.93
1919-20	1.67	2.89	1.94	.966	.822	3.15	7.74	4.78	1.64	1.03	.979	1.19	2.40
1920-21	1.73	1.55	3.64	1.88	1.26	5.30	4.16	1.73	.801	.884	.884	.692	2.05
1921-22	.856	1.53	1.82	1.14	.989	3.48	6.54	3.71	5.28	2.57	1.10	.966	2.50
1922-23	.986	.932	.836	1.15*	.637*	1.02*	6.68	3.55	1.01	.705	.677	.625	1.57
1923-24	.842	1.41	2.38	1.83	1.34	1.40	4.74	4.42	1.10	.808	.712	1.84	1.90
1924-25	1.45	1.45	1.31	.932	2.85	.388	3.77	2.14	1.26	1.78	1.08	1.14	1.91
1925-26	1.82	2.65	1.98	1.28	1.29	1.29	4.03	3.79	1.46	1.14	.836	.808	1.86
1926-27	1.21	2.48	1.16	1.04	.973	2.78	2.71	2.11	1.23	1.32	1.03	.993	1.59
1927-28	1.66	5.08	2.95	1.55	1.42	1.70	4.79	4.12	2.31	1.55	1.52	1.18	2.48
1928-29	1.03	1.16	1.02	1.19	.890	2.82	5.36	4.94	1.40	.932	.753	.740	1.86

* Estimated.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Merrimack River at Manchester, N. H.

(Drainage area, 2,840 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1924	—	—	—	1.65	.870	1.42	5.53	3.48	.764	.465	.408	1.09	—
1924-25	.782	.792	.806	.419	1.91	3.77	3.41	1.56	.813	1.02	.623	.592	1.37
1925-26	.972	1.71	1.73	1.04	.810	1.23	4.82	2.78	.891	.630	.433	.384	1.45
1926-27	.662	1.85	.905	.775	.813	3.08	2.11	1.60	.838	.845	.697	.778	1.25
1927-28	1.15	3.80	2.75	1.64	1.69	1.87	4.23	3.70	2.07	1.21	1.19	1.05	2.19
1928-29	.732	.764	.778	1.13	.824	2.97	4.47	4.08	.993	.585	.454	.430	1.52

NOTE. — Record furnished by Amoskeag Manufacturing Company.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Merrimack River at Garvins Falls, N. H.

(Drainage area, 2,340 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1904	—	—	—	—	—	—	—	—	—	—	—	.947	—
1904-05	1.22	.856	.710	.936	.690	2.74	4.45	1.67	1.17	.824	.823	2.67	1.56
1905-06	.978	1.10	1.66	2.12	1.33	1.44	4.74	3.49	2.97	1.51	.966	.598	1.91
1906-07	.812	.962	.829	1.33	.885	1.87	3.88	2.94	1.50	.979	.637	.944	1.46
1907-08	2.34	3.74	2.47	1.69	1.77	2.81	3.94	4.03	1.32	.786	.996	.521	2.20
1908-09	.500	.556	.534	.970	1.47	1.74	6.07	2.86	1.23	.551	.453	.538	1.45
1909-10	.573	.564	.577	1.23	1.00	3.51	3.26	1.75	1.35	.581	.701	.603	1.31
1910-11	.500	.701	.496	.897	.556	1.05	4.27	2.04	.829	.466	.530	.675	1.08
1911-12	1.38	1.41	1.20	1.16	1.21	2.51	5.25	2.92	1.68	.621	.753	1.08	1.76
1912-13	.976	.943	.788	2.70	1.63	4.61	3.36	2.04	1.66	.783	.575	.626	1.73
1913-14	1.14	1.45	1.24	.906	1.00	3.18	6.28	3.60	1.06	.876	.735	.701	1.85
1914-15	.598	.709	.735	1.27	2.35	2.01	2.72	1.60	.799	3.10	2.42	1.04	1.61
1915-16	1.00	1.19	1.69	1.70	2.03	—	—	—	—	—	—	—	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Merrimack River at Lawrence, Mass.

(Drainage area, 4,452 square miles since March 7, 1898)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	Aprtl	May	June	July	Aug.	Sept.	Mean for Year
1879-80	.534	.949	1.54	1.62	2.69	2.29	2.36	1.21	.696	.646	.554	.490	1.30
1880-81	.388	.929	.580	.540	1.03	3.64	3.51	3.10	1.09	.751	.611	.549	1.39
1881-82	.545	1.16	1.83	1.60	2.02	3.48	2.27	2.32	1.96	.687	.470	.812	1.60
1882-83	.678	.505	.472	.442	.634	.861	3.38	1.85	1.10	.684	.423	.266	.942
1883-84	.432	.627	.515	1.02	2.05	3.34	5.66	2.58	.893	.500	.461	.426	1.54
1884-85	.400	.522	1.02	1.14	.938	.738	3.97	1.84	.917	.623	1.19	.632	1.16
1885-86	.749	1.99	1.50	2.86	3.80	2.58	4.93	1.48	.714	.497	.435	.434	1.83
1886-87	.471	1.54	1.30	1.64	2.82	1.77	4.79	3.00	1.79	1.46	1.87	.918	1.95
1887-88	.682	.966	1.34	1.39	1.82	2.17	5.38	4.54	1.23	.548	.577	1.54	1.85
1888-89	2.66	2.89	3.18	2.62	1.34	2.38	2.41	1.44	1.17	.782	1.09	.750	1.89
1889-90	1.22	1.92	2.81	1.49	1.66	3.33	3.73	3.10	1.72	.691	.745	1.83	2.02
1890-91	2.65	1.92	1.42	2.82	2.85	5.04	4.64	1.60	.990	.633	.538	.556	2.14
1891-92	.467	.540	.899	1.84	.925	1.56	1.77	2.22	1.27	1.04	1.05	.863	1.20
1892-93	.467	1.42	.859	.645	1.08	2.28	3.36	4.20	.963	.522	.564	.608	1.41
1893-94	.790	.736	1.17	.661	.933	3.12	2.40	1.52	1.32	.498	.370	.400	1.16
1894-95	.493	.772	.661	.626	.507	1.26	4.29	1.36	.664	.565	.477	.366	1.00
1895-96	.863	2.05	2.02	1.42	1.94	4.51	3.97	.971	.769	.446	.441	.683	1.67
1896-97	1.13	1.45	.952	.745	1.00	2.29	3.84	2.21	2.77	2.36	1.10	.603	1.70
1897-98	.482	1.27	2.26	1.61	1.64	4.04	3.32	2.40	1.42	.585	.776	.636	1.70
1898-99	1.37	2.09	1.87	1.66	1.03	2.48	5.76	2.12	.667	.556	.467	.447	1.71
1899-1900	.401	.625	.622	.748	3.52	3.44	4.09	2.18	.878	.407	.420	.338	1.47
1900-01	.564	1.30	1.49	.752	.546	2.06	5.57	3.34	1.66	.644	.989	.588	1.62
1901-02	.913	.654	2.05	2.27	1.20	6.01	3.80	2.25	1.19	.970	.844	.774	1.91
1902-03	1.60	1.28	1.76	1.68	1.98	6.03	3.38	.979	2.22	1.03	.734	.530	1.93
1903-04	.826	.665	.825	.584	.644	2.72	4.49	3.84	1.02	.624	.573	.653	1.46
1904-05	.816	.604	.407	.855	.503	2.35	3.62	1.17	.931	.600	.606	1.71	1.18
1905-06	.727	.760	1.27	1.70	1.13	1.68	3.59	2.27	2.26	1.11	.741	.422	1.47
1906-07	.549	.707	.566	1.41	.667	1.73	2.92	2.03	1.19	.749	.431	.664	1.14
1907-08	1.43	2.91	2.18	1.95	1.65	2.50	2.65	2.57	.932	.522	.668	.379	1.70
1908-09	.330	.354	.420	.677	1.56	1.70	3.40	1.95	.948	.447	.376	.369	1.04
1909-10	.422	.388	.504	1.04	.973	3.61	2.44	1.51	1.08	.398	.458	.397	1.10
1910-11	.300	.457	.335	.624	.482	1.25	3.04	1.36	.551	.266	.328	.435	.786
1911-12	.918	1.05	1.28	.802	.706	2.77	4.32	2.30	1.30	.412	.499	.485	1.40
1912-13	.733	1.24	1.07	1.78	.987	3.37	2.49	1.44	.899	.393	.306	.387	1.26
1913-14	.791	.967	1.05	.734	.958	3.24	4.95	2.88	.737	.559	.434	.445	1.48
1914-15	.303	.356	.437	1.08	1.74	1.48	1.79	1.13	.489	1.81	2.06	.655	1.11
1915-16	.657	.874	1.30	1.53	1.67	1.74	4.32	2.73	3.10	1.53	.924	.972	1.77
1916-17	.798	.743	1.15	1.02	.770	2.32	3.24	2.12	3.04	1.02	.629	.549	1.45
1917-18	.613	.882	.569	.466	.819	1.98	3.34	1.54	.757	.553	.470	.847	1.07
1918-19	.991	1.13	1.49	1.31	.872	3.38	2.54	2.74	1.01	.539	.401	.653	1.43
1919-20	.699	1.65	1.33	.570	.618	4.08	6.00	3.54	1.61	.746	.678	.680	1.85
1920-21	1.05	.921	3.26	1.68	.995	3.69	2.70	1.96	.597	1.03	.683	.425	1.58
1921-22	.475	1.06	1.65	.830	.887	3.90	4.90	2.89	3.01	2.11	.773	.766	1.94
1922-23	.660	.612	.498	1.07	.855	1.96	4.96	2.90	.730	.434	.394	.303	1.28
1923-24	.491	1.18	2.37	1.96	.978	1.77	5.05	3.12	.920	.464	.350	.753	1.62
1924-25	.612	.536	.712	.357	1.88	3.41	3.10	1.35	.689	.712	.518	.454	1.19
1925-26	.735	1.07	1.58	1.03	.796	1.65	3.93	2.16	.843	.527	.405	.341	1.26
1926-27	.509	1.40	.872	.955	1.05	3.16	1.83	1.42	.785	.645	.708	.949	1.19
1927-28	1.40	3.73	3.02	2.04	2.07	2.05	3.43	3.16	2.30	1.64	1.55	1.50	2.32
1928-29	.977	.979	1.12	1.54	1.49	3.65	3.99	3.42	.973	.583	.400	.365	1.62

NOTE. — Record furnished by Essex County.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Smith River near Bristol, N. H.

(Drainage area, 78.5 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1918	—	—	—	—	—	—	—	—	.591	.264	.279	.850	—
1918-19	1.31	1.29	2.61	1.86	.629	6.05	3.53	3.91	.522	.219	.146	.488	1.90
1919-20	.833	3.62	2.61	.605	.391	4.75	6.97	3.59	.972	.496	.301	.336	2.13
1920-21	.841	.957	3.62	1.15	.685	5.55	3.20	1.08	.386	.561	.339	.194	1.55
1921-22	.317	1.09	1.64	.811	.981	4.74	6.45	2.62	4.08	1.22	.473	.335	2.06
1922-23	.330	.399	.284	1.28	.472	1.24	7.22	2.78	.525	.189	.117	.130	1.24
1923-24	.339	1.69	2.84	2.24	.689	1.13	7.27	3.41	.503	.335	.385	1.41	1.85
1924-25	.620	.834	1.89	.553	2.66	5.42	3.62	1.50	.846	1.68	.666	.567	1.73
1925-26	1.16	2.52	3.13	1.19	.522	1.30	6.10	2.74	.843	.405	.390	.257	1.72
1926-27	.740	2.20	.592	.509	.408	4.15	2.84	1.62	.659	.474	.487	.625	1.29
1927-28	1.48	4.83	2.66	1.52	1.17	2.65	5.58	3.40	1.66	1.03	.669	.657	2.27
1928-29	.540	.670	.968	1.36	.702	5.96	5.62	3.24	.578	.318	.217	.386	1.72

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Contoocook River near Elmwood, N. H.

(Drainage area, 168 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1917-18	1.01	1.17	.558	.613	1.59	3.52	4.46	1.62	.881	.455	.351	1.03	1.43
1918-19	.607	.929	1.89	1.74	.810	4.14	2.36	3.77	.821	.436	.395	.574	1.55
1919-20	.429	1.18	1.43	.378	.357	5.56	7.26	2.52	1.42	.649	.988	.587	1.90
1920-21	1.18	1.43	5.41	1.67	1.13	5.57	3.29	2.81	.643	1.18	.619	.374	2.12
1921-22	.449	.738	1.39	.732	.905	4.99	5.54	2.38	3.53	1.77	.804	.661	1.99
1922-23	.562	.619	.483	1.73	1.10	3.61	6.19	2.14	.546	.414	.393	.338	1.51
1923-24	.534	1.80	2.96	2.81	1.15	2.08	6.85	2.51	.368	.199	.240	.402	1.82

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Contoocook River at West Hopkinton, N. H.

(Drainage area, 425 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1903	—	—	—	—	—	—	—	—	—	—	.861	.565	—
1903-04	1.15	.932	—	—	—	—	8.82	5.25	1.21	.984	.800	1.10	—
1904-05	1.04	.911	—	—	—	—	6.38	1.47	1.04	.565	.840	2.45	—
1905-06	.713	.849	—	—	—	—	5.88	3.36	2.75	1.37	.624	.386	—
1906-07	.598	1.01	—	—	—	—	3.95	—	—	—	—	—	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Nubanusit Brook near Peterboro, N. H.

(Drainage area, 54.3 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1920-21	—	—	4.03	1.64	1.14	5.25	3.26	2.87	.641	1.24	.720	.451	—
1921-22	.501	.621	1.56	.954	1.01	4.38	5.84	2.34	3.65	1.56	.757	.613	1.99
1922-23	.554	.632	.495	1.79	.726	3.46	5.58	2.76	.564	.315	.562	.302	1.48
1923-24	.668	2.06	3.37	1.71	1.74	1.31	5.84	2.80	.565	.363	.530	.626	1.79
1924-25	.532	.479	.901	.764	1.79	3.85	2.38	1.15	.547	.376	.453	.608	1.15
1925-26	.536	.591	1.56	.794	1.20	2.84	4.73	1.29	.694	.560	.536	.392	1.31
1926-27	.479	1.46	1.02	.912	.724	.405	1.40	1.44	1.03	.558	.610	.606	1.20
1927-28	.750	3.76	3.02	2.14	1.33	1.56	2.93	3.06	2.23	1.30	2.34	2.47	2.23
1928-29	1.26	.746	.897	1.60	.444	3.90	—	—	—	—	—	.348	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

North Branch of Contoocook near Antrim, N. H.

(Drainage area, 59.5 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1924-25	.262	.402	.287	.193	3.48	4.29	3.48	1.12	.444	.395	.210	.157	1.21
1925-26	.286	1.29	2.24	1.03	.943	1.20	5.65	2.59	.539	.521	.484	.376	1.43
1926-27	.509	1.93	.973	.818	.766	3.33	2.54	1.90	.830	.434	.484	.356	1.24
1927-28	.834	5.03	3.19	1.95	1.36	1.83	4.49	4.24	2.99	1.31	1.70	1.55	2.54
1928-29	.817	.595	1.03	1.43	.889	4.39	5.95	3.93	.570	.271	.182	.118	1.68

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Blackwater River near Contoocook, N. H.

(Drainage area, 131 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1918	—	—	—	—	—	—	—	—	.739	.445	.537	1.36	—
1918-19	1.15	1.36	1.95	1.79	.786	5.15	3.21	4.22	1.11	.402	.299	.464	1.84
1919-20	.376	2.44	1.65	.327	.451	6.15	8.63	3.38	1.22	.615	.683	.615	2.21
1927	—	—	—	—	—	4.39	2.13	1.41	.702	.604	.582	.817	—
1927-28	1.36	4.45	3.29	1.86	2.19	2.09	4.93	3.51	1.93	1.31	.977	.893	2.40
1928-29	.531	.531	.683	1.21	.809	5.66	5.43	3.31	.786	.375	.294	.327	1.67

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Suncook River at North Chichester, N. H.

(Drainage area, 157 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1918	—	—	—	—	—	—	—	—	.509	.511	.499	.815	—
1918-19	1.05	1.45	2.41	1.97	.968	4.66	2.68	2.94	.720	.508	.292	2.38	1.67
1919-20	.224	1.38	1.72	.643	.513	6.43	6.12	2.58	1.03	.514	.720	1.48	1.95
1921	—	—	—	—	—	—	—	—	—	.656	.332	.411	—
1921-22	.257	.564	1.89	1.03	1.01	5.94	5.30	2.44	2.71	1.31	.561	.508	1.97
1922-23	.359	.290	.233	.930	.573	1.64	7.07	2.76	.580	.461	.124	.139	1.26
1923-24	.390	1.09	2.76	2.54	1.20	2.06	6.56	2.31	.656	.157	.140	.524	1.70
1924-25	.255	.306	.885	.389	4.27	6.15	3.17	1.08	.662	.522	.349	.151	1.50
1925-26	.334	.898	1.52	1.24	1.21	1.69	5.80	1.60	.644	.464	.175	.068	1.30
1926-27	.171	1.48	1.04	.968	.815	4.52	1.61	1.12	.662	.669	.745	.943	1.23

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Souhegan River at Merrimack, N. H.

(Drainage area, 168 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1909	—	—	—	—	—	—	—	—	—	—	.233	.209	—
1909-10	.229	.229	.411	1.59	1.23	8.45	2.95	1.57	1.35	.249	.245	.208	1.57
1910-11	.237	.365	.353	.774	.303	2.71	2.96	.833	.732	.222	.238	.348	.839
1911-12	1.50	1.74	2.28	1.40	1.14	4.95	4.70	2.32	.738	.266	.283	.260	1.80
1912-13	.339	1.41	1.53	2.59	1.04	4.21	2.96	1.55	.577	.289	.392	.378	1.45
1913-14	1.28	1.29	1.49	1.05	1.55	5.57	6.07	3.04	.525	.405	.246	.183	1.89
1914-15	.130	.162	.274	1.57	2.85	1.67	1.65	1.12	.292	2.33	4.58	.580	1.43
1915-16	.649	.988	1.96	2.60	2.78	2.77	6.43	3.21	3.58	1.14	.685	.607	2.27
1916-17	.394	.524	.815	1.03	.899	4.33	3.80	2.39	2.65	.786	.530	.423	1.55
1917-18	.619	.833	.571	.532	1.65	3.79	3.73	1.18	.881	.351	.276	1.10	1.29
1918-19	.512	.768	1.55	1.73	.863	5.17	3.00	3.28	.726	.311	.194	.465	1.56
1919-20	.279	2.05	1.94	.519	.596	7.20	6.79	3.05	1.61	.479	.422	.334	2.11
1920-21	1.21	1.34	4.68	1.88	1.11	4.64	3.19	3.24	.442	.976	.518	.230	1.97
1921-22	.239	.952	2.35	.976	1.28	5.85	4.74	3.17	3.34	2.23	.792	.561	2.21
1922-23	.643	.649	.483	1.90	1.25	3.56	6.07	2.38	.619	.333	.234	.224	1.53
1923-24	.515	1.72	3.30	2.77	1.10	2.20	7.02	3.38	.661	.262	.200	.230	1.95
1924-25	.164	.233	.458	.151	2.21	4.39	2.83	1.22	.444	.552	.355	.236	1.10
1925-26	.489	1.50	3.24	.875	.899	2.65	5.40	1.36	.583	.239	.180	.132	1.46
1926-27	.310	1.51	.994	.863	1.29	5.07	1.64	1.43	.582	.267	.548	1.08	1.30
1927-28	.976	4.10	3.74	2.15	2.34	2.14	3.57	3.16	2.39	2.01	1.94	2.09	2.55
1928-29	.708	.679	.851	1.52	—	—	5.45	3.39	.780	.312	—	.143	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

South Branch of Nashua River (Wachusett Drainage Basin) near Clinton, Mass.

(Drainage area, 108.84 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1896	—	—	—	—	—	—	—	—	—	.519	.467	.707	—
1896-97	1.228	1.410	1.447	1.232	1.440	4.270	2.525	1.800	1.828	2.231	1.386	.588	1.787
1897-98	.377	1.984	3.521	2.418	2.530	4.778	3.137	2.151	1.281	.514	2.049	1.045	2.149
1898-99	2.334	3.358	3.189	3.236	1.687	4.295	5.224	1.334	.869	.548	.365	.387	2.238
1899-1900	.379	.665	.555	1.232	6.271	5.759	2.444	2.139	.894	.336	.304	.197	1.735
1900-1901	.437	1.354	2.429	.803	.551	4.205	7.711	4.222	1.525	.738	.792	.495	2.111
1901-02	1.001	.799	5.002	2.579	2.168	6.176	3.341	1.595	.635	.452	.459	.372	2.056
1902-03	1.471	.982	2.859	1.957	3.300	5.297	3.463	.880	3.297	.966	.734	.580	2.140
1903-04	1.065	.981	1.476	1.020	1.434	4.653	4.617	2.317	1.179	.769	.549	.764	1.735
1904-05	.538	.530	.680	1.959	.700	4.648	2.502	.688	.838	.565	.497	1.900	1.341
1905-06	.567	.684	1.575	1.751	1.588	2.878	3.263	2.371	1.831	1.127	.915	.428	1.582
1906-07	.820	1.160	1.229	2.257	1.070	2.626	2.221	1.494	1.196	.518	.135	1.254	1.332
1907-08	2.138	3.930	3.035	2.689	2.685	3.391	1.964	2.188	.624	.341	.685	.136	1.989
1908-09	.245	.194	.599	.916	3.955	3.294	3.748	1.876	.977	.361	.299	.321	1.379
1909-10	.139	.561	.831	2.857	2.854	4.084	1.600	.941	1.274	.096	.288	.224	1.304
1910-11	.106	.548	.605	1.196	.967	2.072	2.155	.713	.543	.087	.291	.281	.795
1911-12	1.111	1.601	1.650	1.208	1.434	4.380	3.530	2.780	.512	.208	.194	.138	1.564
1912-13	.224	.683	1.227	2.188	1.342	3.501	3.224	1.607	.433	.030	.092	.338	1.241
1913-14	1.049	1.021	1.478	1.532	1.827	4.853	4.012	2.629	.491	.510	.404	.018	1.652
1914-15	.211	.326	.576	3.190	3.034	.885	1.443	.704	.353	1.676	2.564	.244	1.260
1915-16	.599	.770	2.103	2.035	2.810	2.926	5.106	2.626	3.178	1.680	.439	.454	2.053
1916-17	.217	.496	.712	1.062	1.418	3.824	2.272	2.038	1.902	.409	.479	.129	1.245
1917-18	.858	.484	.602	.749	3.131	4.008	2.487	1.042	.809	.433	.246	.933	1.302
1918-19	.528	.900	1.634	2.075	1.228	4.887	2.648	3.410	.715	.619	.405	1.691	1.733
1919-20	.765	2.840	1.999	1.000	1.122	7.248	5.413	3.205	2.974	1.252	.506	.835	2.434
1920-21	.634	2.013	4.007	2.187	1.651	3.883	2.988	3.205	.743	1.579	.380	.176	1.965
1921-22	.245	1.224	1.970	.918	1.560	5.170	3.687	3.046	3.440	2.318	1.231	.798	2.136
1922-23	.671	.871	.856	2.729	1.553	4.751	4.707	2.029	.952	.459	.229	.142	1.658
1923-24	.665	1.507	2.656	2.902	1.235	2.626	6.518	3.052	.695	.203	.390	.494	1.912
1924-25	.099	.427	.609	.488	2.424	3.473	2.228	1.095	.613	.362	.301	.534	1.044
1925-26	.676	1.235	2.513	1.471	1.286	2.920	3.738	1.276	.627	.400	.390	.311	1.403
1926-27	.599	1.355	1.008	1.895	1.714	3.614	1.498	1.408	.665	.864	2.494	1.867	1.583
1927-28	2.006	6.229	4.277	2.305	2.795	1.987	3.302	2.555	3.204	1.411	1.023	1.000	2.343
1928-29	.616	.696	1.040	1.856	2.218	4.260	4.445	3.341	.914	.230	.109	.243	1.664

NOTE. — Record furnished by Metropolitan District Commission.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Sudbury River Basin near Framingham, Mass.

(Drainage area, 75.2 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1874-75	—	—	—	.159	2.315	2.482	4.718	1.838	1.346	.497	.612	.321	—
1875-76	1.000	2.015	.903	.995	2.116	6.862	5.094	1.761	.343	.283	.627	.285	1.859
1876-77	.361	1.683	.702	1.019	1.469	7.448	3.703	2.153	.924	.312	.187	.092	1.673
1877-78	.977	2.193	1.995	2.800	3.814	5.426	2.516	2.158	.782	.199	.736	.249	1.978
1878-79	.799	2.619	4.916	1.083	2.647	3.605	4.821	1.723	.640	.243	.611	.218	1.988
1879-80	.109	.318	.716	1.733	2.765	2.126	1.808	.796	.271	.273	.184	.124	.928
1880-81	.157	.318	.271	.642	2.392	6.195	2.392	1.493	2.070	.428	.229	.305	1.401
1881-82	.287	.611	1.199	1.920	3.718	4.392	1.342	1.998	.818	.133	.086	.474	1.403
1882-83	.463	.324	.487	.518	1.598	2.492	2.088	1.450	.464	.178	.122	.141	.856
1883-84	.288	.317	.299	1.540	4.397	5.857	4.415	1.594	.644	.346	.397	.068	1.668
1884-85	.129	.271	1.431	1.910	2.095	2.433	2.808	2.067	.659	.096	.372	.187	1.200
1885-86	.519	1.822	1.816	2.260	7.428	3.185	3.013	1.114	.314	.179	.146	.182	1.791
1886-87	.225	1.041	1.578	4.006	4.377	4.437	4.053	1.561	.640	.178	.331	.172	1.867
1887-88	.294	.570	.995	1.629	3.011	5.009	4.093	2.526	.652	.182	.587	1.786	1.771
1888-89	3.093	4.267	4.708	4.305	1.850	2.071	2.182	1.361	1.011	.980	2.216	1.274	2.451
1889-90	1.903	3.003	3.467	1.941	2.366	5.636	2.900	2.114	.878	.166	.204	.708	2.108
1890-91	3.515	1.879	1.541	4.669	5.393	6.891	3.709	.901	.639	.231	.252	.314	2.480
1891-92	.325	.472	.842	2.893	1.459	3.025	1.348	1.947	.662	.331	.433	.355	1.178
1892-93	.195	1.079	.750	.671	2.386	5.021	3.288	4.461	.680	.244	.280	.167	1.571
1893-94	.343	.493	1.252	1.072	1.533	3.463	2.538	1.299	.648	.249	.324	.231	1.119
1894-95	.579	1.293	1.108	1.600	.837	3.728	3.892	.984	.269	.357	.354	.138	1.264
1895-96	2.134	4.296	2.757	1.677	4.140	5.933	2.312	.557	.617	.147	.088	.600	2.095
1896-97	.916	1.020	1.017	1.307	1.651	3.968	2.344	1.416	1.488	1.018	.914	.282	1.447
1897-98	.145	1.407	2.451	2.535	4.676	4.029	2.830	1.927	.820	.357	1.712	.571	1.939
1898-99	1.795	3.073	2.783	3.541	2.137	6.507	3.900	.790	.102	.030	— .054	.145	2.065
1899-1900	.179	.474	.340	1.229	5.880	5.653	2.088	2.031	.489	— .028	— .052	.101	1.504
1900-1901	.287	1.026	1.696	.676	.464	4.262	6.504	4.570	1.165	.473	.655	.473	1.861
1901-02	.637	.734	4.170	2.728	2.590	6.497	2.916	1.149	.469	.101	.208	.276	1.876
1902-03	.782	.688	2.753	2.685	3.526	5.344	3.498	.542	3.075	.689	.475	.201	2.011
1903-04	.761	.561	.901	.738	1.365	4.640	5.096	2.699	.648	.096	.262	.614	1.530
1904-05	.295	.447	.417	2.182	.510	3.864	2.543	.460	.723	.275	.177	1.928	1.154
1905-06	.245	.431	1.373	1.745	1.610	3.727	3.015	1.639	1.093	.615	.279	.030	1.317
1906-07	.466	.747	1.019	2.091	.965	2.565	2.487	1.374	1.178	.014	.161	.837	1.132
1907-08	1.146	3.092	3.143	2.978	2.377	3.492	1.729	1.618	.301	— .022	.157	— .127	1.658
1908-09	.072	.110	.210	.607	3.537	2.683	2.662	1.553	.370	— .187	— .069	.231	.963
1909-10	— .079	.127	.407	2.305	2.861	3.023	1.031	.429	.799	— .158	— .113	.008	.875
1910-11	— .078	.273	.342	.802	1.084	1.771	2.206	.492	.329	— .022	.032	.117	.607
1911-12	.458	.918	1.405	1.127	1.852	4.783	3.459	2.238	.229	— .119	— .046	— .044	1.355
1912-13	— .021	.255	.765	1.611	1.166	3.233	3.453	1.342	.230	— .096	— .083	.136	.998
1913-14	.749	.743	1.132	1.405	1.561	4.686	3.640	2.398	.007	.165	.241	— .210	1.379

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE — *Concluded*
Sudbury River Basin near Framingham, Mass. — Concluded
 (Drainage area, 75.2 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1914-15	— .091	.151	.387	2.520	2.893	.918	.912	.395	.156	1.617	1.808	.059	.968
1915-16	.357	.404	1.390	1.458	2.098	2.815	4.699	2.226	1.853	.906	.121	.040	1.526
1916-17	— .008	.170	.487	.789	1.168	3.417	2.174	2.283	1.615	.066	.313	.090	1.046
1917-18	.746	.678	.589	.422	2.798	3.384	2.267	.989	.286	.149	— .083	.986	1.086
1918-19	.424	.756	1.451	2.021	1.418	4.270	2.651	1.996	.174	.463	.143	1.103	1.408
1919-20	.431	1.973	1.694	.483	1.149	8.033	4.503	2.856	2.625	.439	— .061	.099	2.023
1920-21	— .040	1.035	1.857	1.511	1.307	3.513	1.770	2.565	.265	1.580	.091	— .089	1.287
1921-22	— .151	1.032	1.186	.500	1.264	3.979	3.026	2.712	2.415	1.117	.544	1.016	1.552
1922-23	.422	.573	.633	2.410	1.447	4.908	3.767	1.821	.599	.103	— .112	— .089	1.374
1923-24	.614	1.764	3.400	2.779	1.106	3.002	4.728	2.164	.434	— .081	.179	.632	1.727
1924-25	.010	.256	.424	.285	2.866	3.378	2.306	.899	.335	.370	.089	.061	.928
1925-26	.543	.898	2.888	1.335	1.533	4.218	2.982	1.114	.161	— .106	.360	— .175	1.313
1926-27	.176	1.242	1.037	2.006	2.261	3.178	1.071	1.188	.332	.201	1.464	2.023	1.343
1927-28	2.006	6.229	4.277	2.019	2.546	1.972	2.723	2.188	2.453	1.882	.851	.918	2.505
1928-29	.814	.912	1.301	2.037	2.337	4.121	4.551	2.775	.353	— .172	— .091	— .039	1.575

NOTE. — Record furnished by Metropolitan District Commission.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE
Lake Cochituate Basin near Cochituate, Mass.
 (Drainage area, 17.58 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1863	—	—	—	1.661	2.992	3.221	3.955	1.252	.595	2.553	1.334	.886	—
1863-64	1.135	2.365	1.899	2.088	1.445	3.550	2.374	1.400	.436	.357	.585	.440	1.508
1864-65	1.228	1.112	1.020	1.784	1.690	4.041	2.421	4.121	.298	.396	.414	.397	1.582
1865-66	.603	.917	.983	.641	2.726	1.544	1.452	1.123	.974	1.092	.554	1.181	1.136
1866-67	.813	.872	1.346	.951	5.028	3.014	2.567	1.891	.594	.486	1.820	.279	1.617
1867-68	.912	.991	.975	1.072	1.035	3.339	3.131	5.358	1.430	.395	.985	1.633	1.775
1868-69	.822	1.781	1.017	1.581	1.791	2.888	2.227	1.882	.939	.642	.513	.995	1.419
1869-70	2.024	1.167	2.743	4.107	3.790	2.926	6.152	1.440	.870	.464	.347	.575	2.204
1870-71	.831	.716	.677	.892	2.195	2.199	1.412	1.733	.782	.373	.604	.255	1.049
1871-72	.532	1.105	1.025	.957	.827	1.172	2.655	.951	1.331	.124	1.146	1.522	1.108
1872-73	1.462	1.791	1.048	2.682	1.511	3.378	5.458	2.311	.406	.535	1.215	.700	1.875
1873-74	1.768	1.663	2.328	2.709	2.104	1.597	2.859	2.410	1.753	.821	.800	.477	1.772
1874-75	.454	.521	.441	.115	2.807	2.308	2.823	1.209	1.327	.220	.538	.534	1.092
1875-76	1.037	1.760	1.058	.942	1.656	4.507	3.766	1.236	.453	.735	.254	.519	1.491
1876-77	.313	1.664	.855	1.040	1.318	5.907	2.907	1.765	.823	.560	.568	.362	1.509
1877-78	.973	2.414	1.704	2.816	3.813	4.684	2.559	1.439	.693	.406	.725	.259	1.862
1878-79	.637	1.854	3.501	1.118	2.234	2.860	4.019	1.218	.689	.283	.820	.546	1.642
1879-80	.519	.647	.904	1.276	2.078	1.553	1.405	.382	.051	.283	.202	.217	.788
1880-81	.240	.594	.512	1.035	2.140	4.905	1.607	1.093	1.170	.139	.074	.206	1.137
1881-82	.159	.753	1.220	1.595	2.885	3.185	.836	1.345	.556	.052	.062	.865	1.116

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE—*Concluded**Lake Cochituate Basin near Cochituate, Mass.—Concluded*

(Drainage area, 17.58 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1882-83	.731	.520	.796	.730	1.526	1.769	1.487	1.091	.060	.015	.063	.392	.760
1883-84	.381	.359	.813	1.593	2.656	4.053	3.581	1.203	.603	.227	.530	.120	1.338
1884-85	.294	.557	1.575	1.645	1.919	1.916	2.114	1.401	.383	.000	.291	.227	1.022
1885-86	.684	1.838	1.422	1.980	7.615	3.046	2.261	.943	.172	.217	.117	.266	1.670
1886-87	.360	1.075	1.817	3.524	4.168	4.080	3.011	1.171	.735	.625	1.149	.574	1.844
1887-88	.428	.622	.835	.984	2.568	4.129	3.090	2.056	.478	.407	.815	2.072	1.534
1888-89	2.229	3.775	4.732	3.905	1.778	1.809	1.947	1.038	1.055	1.413	2.973	1.604	2.362
1889-90	1.655	2.642	2.830	1.665	1.955	5.092	1.999	1.608	1.261	.284	.402	1.255	1.888
1890-91	2.953	1.333	1.833	5.428	6.360	6.965	3.865	.764	.690	.432	.626	.682	2.669
1891-92	.681	.743	1.093	2.628	1.446	2.618	.808	1.758	.442	.286	.483	.543	1.131
1892-93	.495	.977	.728	.555	2.450	3.577	2.177	1.585	.671	.330	.669	.378	1.208
1893-94	.923	.749	1.283	1.053	1.607	2.210	1.927	.789	.403	.325	.359	.407	.999
1894-95	.571	.827	.992	1.368	.721	3.032	2.997	.841	.364	.486	.429	.621	1.106
1895-96	1.711	3.145	2.083	1.494	3.419	4.791	1.805	.541	.639	.325	.410	.923	1.766
1896-97	1.113	1.250	1.131	1.421	1.588	2.792	1.659	1.207	1.067	.653	.542	.410	1.235
1897-98	.375	1.510	1.870	1.971	3.894	2.700	2.414	1.615	.700	.321	1.129	.278	1.549
1898-99	1.393	2.073	2.377	2.991	2.223	5.505	2.545	.599	.102	.028	.079	.449	1.697
1899-1900	.543	.446	.352	1.060	4.136	4.020	1.454	1.641	.455	.293	.558	.640	1.283
1900-01	.689	1.087	1.502	.840	.629	3.845	4.649	3.704	1.019	.792	1.101	1.012	1.746
1901-02	1.083	1.034	3.675	2.071	1.934	6.022	2.741	.955	.319	.398	.604	.688	1.709
1902-03	.814	.710	2.052	2.184	2.734	4.311	3.106	.689	2.132	.553	.408	.130	1.644
1903-04	.886	.534	.815	.910	1.167	4.108	4.695	2.032	.489	.059	.398	.901	1.420
1904-05	.364	.758	.698	1.824	.422	3.127	2.064	.531	.643	.180	.571	1.647	1.073
1905-06	.685	.878	1.398	1.363	1.226	3.017	2.388	1.395	.772	.640	.490	.429	1.225
1906-07	.738	.722	.705	1.645	.903	2.061	1.964	1.238	.902	.108	.252	.952	1.016
1907-08	.988	2.361	2.492	2.049	2.412	2.946	1.525	1.331	.315	.245	.184	.030	1.401
1908-09	.108	.123	.387	.633	3.191	2.125	2.145	1.218	.598	.181	.432	.658	.967
1909-10	.142	.373	.558	2.424	2.807	2.412	1.147	.603	1.024	.252	.013	.101	.982
1910-11	.035	.379	.506	.768	1.173	1.736	1.943	.251	.116	.052	.487	.549	.663
1911-12	.786	1.068	1.557	.981	1.783	4.262	3.025	2.245	.417	.062	.118	.351	1.388
1912-13	.425	.516	.953	1.685	1.278	3.126	3.059	1.429	.376	.011	.284	.491	1.137
1913-14	.863	.757	1.329	1.566	1.629	4.831	3.392	2.208	.216	.276	.208	.148	1.430
1914-15	.030	.301	.543	2.874	3.408	.992	.899	.351	.141	1.623	1.605	.150	1.066
1915-16	.472	.596	1.713	1.661	2.671	3.449	4.106	2.532	2.287	1.255	.332	.094	1.759
1916-17	.103	.215	.430	.764	1.235	3.097	1.988	2.185	1.689	.268	.342	.141	1.036
1917-18	1.027	.822	1.030	.783	2.748	2.906	2.054	.947	.322	.251	.050	1.250	1.174
1918-19	.513	.871	1.624	2.097	1.676	3.599	2.293	2.130	.413	.502	.357	1.609	1.473
1919-20	.683	2.468	1.799	.675	2.022	8.483	4.428	2.641	2.897	.677	.238	.293	2.277
1920-21	.149	1.244	2.306	2.040	1.675	3.397	2.020	2.671	.563	2.133	.489	.174	1.580
1921-22	.085	1.183	1.733	.615	1.444	3.852	2.711	2.412	3.114	1.652	.802	1.460	1.753
1922-23	.858	.765	.746	2.826	1.777	4.872	3.150	1.461	.611	.250	.032	.018	1.446
1923-24	.491	1.275	2.893	2.441	1.157	3.049	3.727	2.096	.598	.004	.344	.780	1.571
1924-25	.098	.311	.451	.459	3.149	2.886	1.909	.813	.388	.449	.298	.230	.939
1925-26	.558	.744	2.588	1.332	2.461	4.133	2.532	1.222	.324	.104	.714	.005	1.388
1926-27	.378	1.247	1.180	2.112	2.350	2.544	1.019	.949	.163	.501	1.732	1.928	1.337
1927-28	1.793	2.562	3.617	1.900	2.537	1.709	2.591	1.911	2.096	1.666	.859	.898	2.012
1928-29	.941	.875	1.369	2.021	2.084	4.021	4.358	2.314	.372	.028	.049	.032	1.520

NOTE.—Record furnished by Metropolitan District Commission.

BOSTON SOCIETY OF CIVIL ENGINEERS

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Wading River near Norton, Mass.

(Drainage area, 42.4 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1925	—	—	—	—	—	—	—	—	.573	.229	.175	.264	—
1925-26	.278	1.46	2.67	1.83	2.78	4.43	3.02	1.57	.802	.271	.382	.144	1.63
1926-27	.361	1.64	1.79	2.81	2.74	2.88	1.35	.981	.691	.380	1.88	2.43	1.65
1927-28	1.58	2.41	3.47	2.21	2.67	2.23	2.33	2.45	1.80	1.57	.632	.557	1.99
1928-29	.667	.757	1.16	2.62	2.19	4.27	4.34	3.30	.854	.443	.155	.148	1.74

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Pawtuxet River at Fiskeville, R. I.

(Drainage area, 101.8 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1916	—	—	—	2.22	3.44	3.46	4.16	3.18	3.07	2.39	.957	.379	—
1916-17	.430	.470	.827	1.67	1.26	3.76	2.87	2.41	1.95	.692	.605	.563	1.46
1917-18	.155	1.41	1.19	1.58	3.88	2.74	3.04	1.93	1.11	.405	.707	1.61	1.75
1918-19	.884	1.20	2.05	3.30	2.17	4.33	3.96	3.34	1.13	1.17	.788	2.99	2.28
1919-20	1.25	2.01	2.36	1.02	1.56	8.33	4.58	3.23	3.72	1.19	.690	.307	2.52
1920-21	.306	1.55	2.79	2.42	1.63	3.63	3.29	2.47	.849	2.22	.804	2.82	1.86
1921-22	.204	1.48	2.32	.981	1.73	4.17	3.52	3.04	2.14	3.04	3.12	2.93	2.47
1922-23	1.44	1.13	1.18	3.61	2.36	5.29	3.64	2.32	1.03	.558	.347	.220	1.93
1923-24	1.10	1.80	3.96	3.92	1.75	2.97	5.11	2.93	.950	1.80	.480	.610	2.15
1924-25	.425	.432	.839	.792	3.50	2.96	2.20	1.26	.468	.504	.340	.289	1.15

NOTE. — Record furnished by the Providence Water Supply Board.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Quinebaug River at Jewett City, Conn.

(Drainage area, 712 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1918-19	.947	1.21	1.69	2.58	1.73	4.52	3.81	2.77	1.11	.959	.712	1.98	2.01
1919-20	1.14	1.81	2.56	1.01	1.29	7.13	4.50	3.38	3.08	1.41	.878	.590	2.40
1920-21	.785	1.34	2.87	2.15	1.49	3.61	2.77	2.37	1.11	1.73	1.02	.702	1.84
1921-22	.462	.985	1.98	.881	1.36	3.51	3.36	2.28	1.90	1.95	1.43	2.44	1.88
1922-23	1.13	.954	.871	2.72	1.63	4.28	3.36	2.50	1.00	.667	.587	.427	1.68
1923-24	.771	1.30	3.08	2.96	1.47	2.11	4.62	2.50	1.05	.524	.508	.572	1.78
1924-25	.433	.384	.628	.442	2.12	2.53	1.84	1.20	.714	.680	.683	.487	1.00
1925-26	.587	.990	1.69	1.40	1.94	3.17	2.65	1.40	.792	.473	.617	.344	1.33
1926-27	.515	1.47	1.39	2.29	2.22	2.84	1.57	1.52	1.15	.574	1.12	.874	1.46
1927-28	1.52	4.09	4.09	2.33	3.08	2.16	2.58	2.11	1.63	1.54	1.01	.958	2.25
1928-29	.856	.856	1.10	2.23	2.18	3.81	3.97	3.38	1.03	.539	.386	.282	1.71

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Shetucket River at South Windham, Conn.

(Drainage area, 406 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1919-20	—	2.09	2.44	.911	1.24	6.95	5.07	3.87	3.42	1.48	1.04	.815	—
1920-21	1.30	2.06	4.00	3.05	1.64	4.16	3.23	2.81	.687	1.64	.665	.355	2.14
1928-29	.842	.759	1.02	2.23	2.25	4.16	4.58	4.01	.751	.456	.414	.320	1.82

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Connecticut River at First Connecticut Lake near Pittsburg, N. H.

(Drainage area, 82.5 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1917	—	—	—	—	—	—	2.97	8.55	7.17	1.86	3.73	1.94	—
1917-18	1.85	3.64	.958	.762	.627	.737	4.14	6.45	2.03	3.86	1.06	2.38	2.38
1918-19	5.22	3.40	1.58	1.13	.725	1.35	4.73	7.37	3.00	2.59	1.11	1.27	2.80
1919-20	2.74	3.82	1.55	—*	.209	1.74	6.21	7.81	1.28	3.66	.811	1.39	2.60
1920-21	2.36	1.94	2.33	.860	.614	7.13	6.27	.971	.688	.140	—*	.209	1.97
1921-22	1.30	2.69	.759	.144	.498	1.76	9.46	4.47	5.18	1.08	3.10	.160	2.54
1922-23	.590	1.54	.664	.854	.504	.531	7.08	8.75	3.76	1.29	.909	—*	2.21
1923-24	1.88	2.11	2.46	1.25	.737	.491	2.91	10.59	1.19	2.13	1.63	4.71	2.69
1924-25	1.09	2.37	1.25	.553	2.46	3.13	6.44	4.91	2.80	1.06	.651	2.62	2.43
1925-26	4.76	5.08	1.39	1.29	1.03	—*	2.30	11.9	3.73	1.16	.639	—*	2.79
1926-27	2.31	3.12	.870	.688	.504	1.57	5.91	5.87	2.44	1.45	.577	2.58	2.14
1927-28	3.43	6.34	2.89	.312	.176	1.12	5.34	1.16	2.90	.489	.980	2.59	3.18
1928-29	5.74	4.35	1.97	1.30	1.10	1.34	7.27	12.00	2.65	1.43	.338	1.70	3.32

* Apparent depletion of storage slightly exceeded total discharge past the gage during the month. Discharge corrected for storage.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Connecticut River at Waterford, Vt.

(Drainage area, 1,600 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1927	—	—	—	—	—	—	3.94	3.25	1.36	.700	.598	.466	—
1927-28	2.62	4.88	2.88	1.06	.681	1.27	6.50	5.57	1.98	.525	1.04	1.39	2.53
1928-29	2.35	2.11	1.18	1.22	.537	2.12	6.69	6.38	1.33	.900	.551	.524	2.16

NOTE. — Corrected for storage in First and Second Connecticut Lakes.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Connecticut River at South Newbury, Vt.

(Drainage area, 2,830 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1918	—	—	—	—	—	—	—	—	—	.572	.696	1.71	—
1918-19	3.53	3.29	2.11	1.39	.629	2.96	5.09	3.06	1.09	.466	.336	.883	2.07
1919-20	1.69	2.92	1.71	.375	.307	2.62	7.31	4.28	.943	1.07	.661	1.06	2.08
1920-21	1.48	1.69	3.11	1.12	.622	5.69	3.52	.982	.498	.296	.396	.201	1.64
1921-22	.601	1.60	2.01	—	—	—	—	—	—	—	1.28	.597	—
1922-23	.643	.739	.654	1.40	.456	1.03	6.33	4.56	1.38	.538	.299	.354	1.53
1923-24	.728	1.63	2.53	1.88	.541	.905	4.13	4.95	.898	.898	.770	2.86	1.90
1924-25	.848	1.60	1.28	.413	2.53	3.35	3.89	1.95	1.47	1.43	.572	1.18	1.70
1925-26	2.84	3.30	1.66	.760	.505	.587	4.10	5.58	2.18	1.08	.611	.657	1.99
1926-27	1.89	2.28	1.22	.618	.569	2.59	3.02	2.58	1.16	.611	.527	.428	1.46
1927-28	2.20	5.37	3.01	1.47	.742	1.51	6.08	4.55	1.96	.576	.940	1.07	2.46
1928-29	1.59	1.44	1.05	.993	.502	2.24	5.62	5.16	1.21	.756	.442	.392	1.79

NOTE. — Corrected for storage at First and Second Connecticut Lakes.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Connecticut River at Orford, N. H.

(Drainage area, 3,100 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	mean for Year
1900	—	—	—	—	—	—	—	—	—	—	—	.419	—
1900-01	1.42	2.44	1.67	.945	.716	1.74	7.48	2.91	1.69	1.07	1.19	.510	1.98
1901-02	.726	.552	2.13	1.23	.906	6.61	4.19	3.42	3.09	1.37	1.42	1.11	2.24
1902-03	1.43	1.61	.945	.916	1.07	7.84	3.58	1.08	.997	.745	.684	.355	1.78
1903-04	.419	.477	.497	.253	.268	1.69	4.13	4.65	.971	.458	.639	1.19	1.31
1904-05	1.79	.829	.390	.280	.220	2.29	4.32	2.71	1.35	1.42	1.11	1.75	1.54
1905-06	.845	.984	1.83	2.28	.977	7.23	3.81	4.58	2.12	.848	.577	.516	1.68
1906-07	.890	.861	.632	.632	.384	1.28	4.65	5.13	1.51	1.48	.839	.971	1.61
1907-08	2.88	2.52	3.01	1.42	1.56	2.45	4.13	4.10	1.44	.494	.545	.202	2.06
1908-09	.241	.335	.387	.868	1.29	1.17	8.19	4.65	1.25	.481	.270	.471	1.63
1909-10	.761	.768	.668	1.01	.645	4.13	4.68	2.93	1.95	.526	.784	.561	1.62
1910-11	.658	.810	.490	.813	.439	.790	5.42	3.65	.787	.381	.523	.761	1.29
1911-12	1.39	1.40	2.66	1.00	.458	1.24	7.03	3.48	3.09	.448	.716	1.32	2.02
1912-13	1.29	1.82	1.76	2.82	1.42	6.10	4.29	2.18	1.40	.674	.448	.365	2.05
1913-14	1.01	1.35	1.19	.448	.403	1.48	5.90	3.65	.761	.626	.455	.490	1.48
1914-15	.526	.781	.642	.697	1.58	1.79	2.98	1.65	.774	2.26	1.60	.819	1.34
1915-16	.968	1.45	1.44	1.43	1.67	1.14	5.55	3.08	2.79	1.67	1.07	.677	1.91
1916-17	1.03	1.12	1.96	.842	.584	1.68	5.52	3.58	3.87	1.24	1.58	.832	1.99
1917-18	1.61	1.96	.565	.413	.565	1.52	5.13	3.29	1.23	.826	.677	1.63	1.62
1918-19	3.29	3.15	1.98	1.29	.594	2.87	4.87	2.94	1.08	.477	.352	.877	1.99
1919-20	1.54	2.75	1.63	.365	.294	2.66	7.48	4.13	.939	1.02	.652	.984	2.04
1920-21	1.52	1.66	3.08	1.04	.577	5.65	3.42	.913	.461	.329	.445	.241	1.62

NOTE. — Since 1916 discharge corrected for effect of storage in Connecticut Lakes.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Connecticut River at White River Junction, Vt.

(Drainage area, 4,120 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1911-12	1.39	1.41	2.48	1.00	.459	1.74	7.50	4.00	3.33	.512	.779	1.38	2.16
1912-13	1.81	2.15	1.66	2.60	1.22	5.53	4.44	2.39	1.66	.813	.466	.383	2.10
1913-14	1.03	1.38	1.03	.400	.403	1.60	6.65	3.67	.833	.680	.481	.529	1.56
1914-15	.442	.658	.706	.697	1.58	1.41	3.16	1.68	.731	2.43	1.64	.694	1.32
1915-16	.743	.905	1.18	1.55	1.68	1.22	5.61	3.18	2.82	1.69	1.01	.602	1.84
1916-17	.966	1.06	1.87	.859	.580	1.75	5.53	3.62	3.79	1.24	1.51	.808	1.97
1917-18	1.50	1.93	.558	.408	.636	1.69	5.46	3.18	1.24	.806	.680	1.41	1.63
1918-19	2.89	3.06	1.99	1.33	.609	3.11	4.78	3.13	1.00	.420	.296	.857	1.96
1919-20	1.45	2.77	1.65	.367	.299	2.89	7.52	3.88	.981	.995	.612	.867	2.02
1920-21	1.36	1.38	2.69	1.06	.621	5.68	3.42	1.08	.459	.323	.434	.231	1.58
1921-22	.553	1.39	1.41	.626	.544	3.16	7.94	2.57	2.94	1.86	.915	.617	2.04
1922-23	.626	.733	.595	1.31	.502	1.06	6.36	4.66	1.30	.517	.325	.352	1.53
1923-24	.709	1.49	2.65	1.77	.534	.842	4.95	4.98	.913	.825	.711	2.52	1.91
1924-25	.922	1.42	1.23	.410	2.65	3.71	4.05	2.06	1.34	1.55	.713	1.12	1.76
1925-26	2.65	3.25	1.48	.888	.665	.556	4.66	5.32	1.87	1.05	.568	.609	1.97
1926-27	1.65	2.57	1.18	.672	.643	2.91	2.96	2.48	1.13	.636	.561	.536	1.50
1927-28	2.20	6.14	3.35	1.61	.900	1.61	6.04	4.56	2.25	.745	.954	.983	2.60
1928-29	1.36	1.37	1.01	1.02	.437	2.86	5.85	4.90	1.23	.767	.439	.466	1.82

NOTE. — Beginning October, 1916, discharge corrected for effect of storage in Connecticut Lakes.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Connecticut River at Turners Falls, Mass.

(Drainage area, 7,250 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1916-17	.810	.942	1.46	.877	.574	1.93	4.54	2.86	3.09	.956	.986	.593	1.64
1917-18	1.09	1.41	.477	.379	.672	2.12	4.72	2.46	1.03	.628	.473	1.07	1.38
1918-19	1.94	2.19	1.67	1.24	.644	3.21	3.89	3.10	.811	.404	.259	.767	1.68
1919-20	1.11	2.41	1.43	.414	.354	3.16	7.24	3.31	1.02	.713	.568	.625	1.86
1920-21	1.13	1.24	2.91	1.15	.694	5.72	3.35	1.56	.480	.735	.421	.207	1.64
1921-22	.450	1.11	1.31	.590	.617	3.43	7.10	2.52	2.66	1.53	.731	.556	1.89
1922-23	.484	.601	.383	.978	.542	1.38	5.57	3.57	.952	.422	.255	.276	1.29
1923-24	.650	1.43	2.57	1.72	.703	1.09	5.37	4.00	.753	.592	.488	1.63	1.75
1924-25	.692	1.02	.977	.364	2.18	3.93	3.68	1.70	1.01	1.25	.586	.815	1.52
1925-26	1.79	2.74	1.53	.902	.654	1.02	4.52	3.57	1.37	.850	.440	.458	1.66
1926-27	1.18	2.28	.990	.723	.731	3.08	2.46	2.00	.920	.560	.516	.516	1.33
1927-28	1.60	5.14	3.26	1.70	1.30	1.82	4.95	3.81	2.25	.999	1.15	.981	2.41
1928-29	1.05	1.07	.902	1.14	.717	3.52	5.32	3.81	1.09	.662	.441	.484	1.68

NOTE. — Corrected for storage in First and Second Connecticut Lakes. Data furnished by Turners Falls Power Company.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Connecticut River at Sunderland, Mass.

(Drainage area, 8,000 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1904	—	—	—	—	—	—	4.74	3.84	.912	.486	.556	.969	—
1904-05	1.56	.820	.561	.341	.261	2.02	4.72	1.96	1.12	.994	1.20	2.58	1.51
1905-06	.940	.984	1.91	2.49	1.32	1.72	4.70	3.26	2.16	1.03	.602	.419	1.82
1906-07	.590	.896	.686	1.18	.588	2.08	4.05	3.70	1.42	1.13	.604	.846	1.49
1907-08	2.65	3.48	2.68	1.56	1.88	3.09	4.05	3.96	1.28	.448	.560	.229	2.16
1908-09	.229	.256	.424	.745	1.52	1.86	6.72	3.55	1.34	.404	.364	.319	1.48
1909-10	.554	.498	.564	1.61	1.02	5.02	3.72	2.22	1.85	.406	.524	.388	1.54
1910-11	.419	.620	.351	1.25	.520	1.12	4.46	2.42	.759	.281	.356	.684	1.10
1911-12	2.04	1.59	2.28	1.14	.562	1.76	6.38	3.10	2.34	.401	.516	.954	1.91
1912-13	1.60	2.01	1.74	2.88	1.55	4.92	3.79	1.90	1.14	.438	.391	.284	1.89
1913-14	.739	1.16	.941	.456	.396	1.91	6.69	3.36	.652	.542	.395	.435	1.48
1914-15	.314	.424	.541	.745	1.96	1.65	2.74	1.38	.550	2.35	2.20	.711	1.29
1915-16	.711	.900	1.44	2.11	2.71	1.71	5.68	2.98	2.55	1.49	.796	.706	1.98
1916-17	.876	1.02	1.75	.991	.580	2.15	4.91	3.06	3.30	.991	1.00	.648	1.78
1917-18	1.10	1.52	.606	.499	.921	2.82	5.15	2.56	1.10	.639	.538	1.08	1.54
1918-19	1.88	2.22	1.78	1.32	.788	3.52	3.96	3.51	.830	.458	.322	.849	1.80
1919-20	1.09	2.50	1.80	.650	.494	3.42	7.39	3.65	1.22	.776	.746	.688	2.04
1920-21	1.17	1.29	3.09	1.44	.952	5.71	3.56	1.89	.545	.950	.554	.296	1.80
1921-22	.428	1.12	1.64	.844	.860	4.18	6.78	2.79	2.79	1.66	.765	.652	2.04
1922-23	.578	.645	.555	1.10	.720	1.46	5.75	3.80	1.05	.441	.332	.369	1.40
1923-24	.791	1.48	3.00	2.38	.862	1.35	5.52	4.35	.794	.610	.530	1.68	1.95
1924-25	.749	1.03	1.13	.454	2.88	4.09	3.90	1.81	1.04	1.31	.668	.894	1.65
1925-26	1.82	2.81	1.90	1.10	.932	1.36	4.91	3.92	1.41	.815	.420	.441	1.82
1926-27	1.13	2.39	1.17	.881	.839	3.60	2.62	2.09	.938	.572	.458	.529	1.44
1927-28	1.69	5.39	3.58	1.88	1.51	1.92	5.08	4.02	2.49	1.10	1.35	1.16	2.59
1928-29	1.01	1.05	1.01	1.31	.701	3.72	5.61	4.39	1.10	.599	.360	.368	1.78

NOTE. — Since 1924, corrected for storage at Connecticut Lakes, Somerset and Davis Bridge reservoirs.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Israel River above South Branch, near Jefferson Highlands, N. H.

(Drainage area, 8.7 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1903-04	1.07	—	—	—	—	—	4.56	7.59	1.16	.743	1.64	2.84	—
1904-05	3.03	2.01	—	—	—	—	—	5.56	3.57	2.26	4.89	4.77	—
1905-06	2.15	1.52	—	—	—	—	—	7.33	3.80	1.44	.901	1.11	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Israel River below South Branch, near Jefferson Highlands, N. H.

(Drainage area, 21.2 square miles)

Year	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1903-04	.802	—	—	—	—	—	4.08	7.17	1.18	.821	1.43	2.71	—
1904-05	2.94	2.51	—	—	—	—	—	5.14	3.25	2.07	4.81	3.68	—
1905-06	1.67	1.13	—	—	—	—	—	7.03	3.45	1.51	1.13	1.33	—
1906-07	1.25	1.33	—	—	—	—	5.75	—	—	—	—	—	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Passumpsic River at Pierce's Mills, near St. Johnsbury, Vt.

(Drainage area, 237 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1909	—	—	—	—	—	—	—	2.05	1.15	.536	.456	.650	—
1909-10	.734	.781	.658	1.91	1.16	4.19	3.89	2.68	1.81	.654	.684	.705	1.66
1910-11	.734	.840	.591	.802	.422	.781	5.78	2.62	.844	.570	.629	.844	1.29
1911-12	1.21	1.38	2.38	1.22	.506	1.48	6.88	3.35	2.36	.477	.616	1.27	1.92
1912-13	1.35	1.89	1.68	2.53	1.35	5.74	3.76	1.57	1.01	.692	.422	.355	1.87
1913-14	.882	.878	.865	.506	.485	1.24	5.40	2.74	.679	.561	.443	.481	1.27
1914-15	.443	.616	.612	.717	1.14	1.26	3.03	1.32	.751	2.03	1.84	1.11	1.24
1915-16	.992	1.01	1.54	2.30	1.92	2.16	4.81	1.30	2.32	1.56	1.29	1.10	1.97
1916-17	1.27	1.72	1.75	1.07	.916	1.98	5.23	2.90	2.62	1.56	2.03	1.09	2.01
1917-18	2.35	1.78	.899	.527	.790	1.73	5.32	2.89	1.76	1.03	.776	1.59	1.79
1918-19	3.50	2.74	2.02	1.88	.827	3.15	4.56	2.51	1.14	.469	—	—	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Ammonoosuc River at Bretton Woods, N. H.

(Drainage area, 34 square miles)

[illegible]

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

White River at Sharon, Vt.

(Drainage area, 654 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1903	—	—	—	—	—	—	—	—	—	.751	.793	.488	—
1903-04	.734	.566	.505	.350	.311	1.80	4.78	2.69	.614	.311	.337	1.18	1.18
1904	2.40	2.44	—	—	—	—	—	—	—	—	—	—	—
1909	—	—	—	—	—	—	—	2.72	1.29	.352	.289	.249	—
1909-10	.346	.399	.362	.827	1.07	4.83	2.77	1.90	2.17	.505	.859	.865	1.41
1910-11	.810	1.01	.847	1.37	.528	1.14	5.76	1.88	.573	.375	.515	.856	1.30

NOTE. — Drainage area, 643 square miles June, 1903, to November, 1904.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

White River at West Hartford, Vt.

(Drainage area, 687 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1915	—	—	—	—	—	—	—	—	.454	1.51	.977	.403	—
1915-16	.408	.613	.996	2.15	1.72	1.62	5.49	2.58	2.18	1.04	.316	.281	1.62
1916-17	.453	.894	1.16	.940	.571	2.08	5.36	2.91	2.90	.735	.457	.287	1.56
1917-18	1.22	1.07	.505	.361	.956	2.46	5.76	2.26	.843	.492	.348	.945	1.43
1918-19	1.75	2.50	2.15	1.54	.635	4.03	4.19	3.23	1.06	.317	.218	.876	1.88
1919-20	1.24	2.43	1.75	.323	.309	4.08	8.12	2.79	.895	.809	.325	.295	1.95
1920-21	1.05	.940	2.59	1.19	.814	7.23	2.87	1.70	.326	.374	.346	.191	1.64
1921-22	.406	1.30	1.32	.827	.710	4.89	8.44	2.47	2.24	1.53	.500	.374	2.08
1922-23	.402	.439	.345	1.18	.510	1.51	7.16	3.00	.820	.281	.191	.204	1.34
1923-24	.614	.980	3.28	2.02	.579	.972	7.03	4.96	.827	.441	.301	.836	1.91
1924-25	.629	.661	.884	.287	2.42	5.34	3.83	2.02	1.04	1.16	.704	.923	1.65
1925-26	1.92	3.04	1.81	.990	.876	1.14	6.71	4.32	1.38	.882	.517	.392	2.00
1926-27	1.85	3.16	1.13	.984	1.03	4.21	2.34	1.92	.828	.792	.668	.587	1.63
1928-29	.483	.687	.795	1.08	.515	4.53	7.45	3.94	1.25	.764	.355	.528	1.86

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Mascoma River at Mascoma, N. H.

(Drainage area, 148 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1923-24	.320	.428	1.01	1.18	.932	1.08	5.63	2.80	.858	.703	.598	1.14	1.39
1924-25	.885	.730	.811	.657	1.50	4.07	3.23	1.42	.831	1.36	1.02	.845	1.45
1925-26	1.05	2.01	1.35	.939	1.05	1.02	4.25	2.82	.736	.770	.689	.600	1.44
1926-27	.612	1.40	.899	.657	.703	2.31	2.26	1.40	.831	.682	.630	.584	1.08
1927-28	.640	3.78	2.66	1.47	1.41	1.46	4.56	3.18	1.64	.959	.905	.872	1.95
1928-29	.614	.599	.630	1.04	.464	3.30	5.55	3.49	.743	.226	.249	.353	1.44

NOTE. — 1928-29, corrected for storage.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

West River at Newfane, Vt.

(Drainage area, 310 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1919-20	1.24	3.17	2.20	.636	.352	5.48	7.90	2.62	1.10	.435	.503	.332	2.17
1920-21	.968	1.60	3.07	1.28	.642	6.84	3.32	1.99	.423	1.36	.265	.171	1.84
1921-22	.255	.984	1.78	.839	.665	5.68	6.29	2.99	2.95	.461	.384	.339	1.97
1922-23	.300	.545	.548	1.13	.706	2.16	7.16	2.48	.690	.371	.277	.293	1.38
1928-29	.497	.629	1.15	1.52	.519	6.19	8.03	3.68	.910	.288	.239	.355	2.01

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Ashuelot River near Gilsum, N. H.

(Drainage area, 68.5 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1922-23	.469	.650	.585	2.29	.632	1.41	8.13	2.70	.393	.434	.419	.359	1.53
1923-24	.623	2.69	3.82	2.50	.966	1.13	9.04	3.88	.464	.407	.353	.496	2.19
1924-25	.394	.384	1.06	.228	3.68	5.55	3.52	1.03	.699	.724	.419	.497	1.50
1925-26	.752	2.57	2.54	2.50	.663	1.10	6.23	2.55	.721	.397	.261	.261	1.71
1926-27	.715	3.00	1.27	.868	.540	3.84	3.08	2.31	.801	.642	.613	.663	1.53
1927-28	1.38	5.61	3.24	1.75	1.43	2.36	4.50	4.54	3.12	1.26	2.04	1.52	2.73
1928-29	.839	.664	.765	1.31	.854	4.95	6.83	4.63	.682	.375	.375	.274	1.88

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Ashuelot River at Hinsdale, N. H.

(Drainage area, 440 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1907	—	—	—	—	—	—	3.07	1.68	1.35	.757	.389	.864	—
1907-08	2.25	3.55	2.70	2.05	2.16	3.14	3.02	2.64	.709	.355	.470	.213	1.94
1908-09	.153	.158	.382	.789	1.62	1.82	4.89	1.75	.900	.293	.277	.201	1.10
1909-10	.255	.219	.305	1.60	1.54	4.82	2.36	1.28	.686	.234	.264	.234	1.15
1910-11	.141	.302	.484	1.20	.784	1.17	3.41	1.23	.450	.193	.339	.459	.845
1911	1.92	1.52	1.62	—	—	—	—	—	—	—	—	—	—
1914	—	—	—	—	—	—	—	—	—	—	.305	.232	—
1914-15	.234	.236	.264	1.12	2.48	1.07	1.58	1.15	.323	2.50	2.32	.530	1.15
1915-16	.580	.586	1.73	2.05	1.81	1.88	5.50	2.02	2.61	1.45	.791	1.44	1.86
1916-17	.993	.909	1.77	1.97	1.92	3.48	3.39	1.81	2.89	.636	.729	.300	1.73
1917-18	.332	.959	.405	.284	.595	2.48	4.70	1.25	.768	.409	.277	.989	1.12
1918-19	.748	1.01	1.79	1.35	.691	3.39	2.80	3.41	.673	.309	.262	.584	1.42
1919-20	.373	1.93	1.78	.520	.350	3.80	6.43	3.39	1.43	.502	1.49	.709	1.89
1920-21	1.24	1.65	4.11	1.47	.895	4.75	3.43	2.22	.618	1.47	.393	.439	1.90
1921-22	.507	1.07	1.17	.900	.732	3.89	5.00	2.16	2.27	1.28	.780	.670	1.70
1922-23	.648	.650	.509	1.69	.818	1.70	5.05	2.43	.620	.427	.332	.350	1.27
1923-24	.807	2.20	3.36	2.27	.845	1.43	5.36	2.48	.595	.345	.230	.591	1.71
1924-25	.375	.436	.916	.364	2.55	3.98	2.68	1.17	.566	.527	.384	.380	1.18
1925-26	.580	1.43	1.72	1.45	.900	1.66	4.55	1.76	.723	.416	.293	.268	1.31
1926-27	.541	2.08	.914	.545	.386	3.80	1.93	1.69	.782	.484	.573	.455	1.19
1927-28	.895	4.09	2.82	1.51	1.15	1.53	3.14	2.70	2.45	1.25	2.10	2.08	2.14
1928-29	.773	.645	.793	1.10	.620	3.77	4.36	3.23	.770	.341	.252	.205	1.41

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Minnewawa Brook at Marlboro, N. H.

(Drainage area, 31.7 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1919	—	—	—	—	—	—	—	—	—	—	.476	.659	—
1919-20	.631	2.01	2.40	.757	.600	6.12	7.16	2.62	1.26	.694	1.01	.741	2.17
1920-21	1.25	.902	4.04	1.57	.785	4.73	3.41	2.27	.751	.968	.590	.219	1.80
1921-22	.379	.549	1.39	.981	1.21	—	—	—	—	—	—	—	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Pratt Brook at Chesham, N. H.

(Drainage area, 11.2 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1919	—	—	—	—	—	—	—	—	—	—	.265	.494	—
1919-20	.848	1.15	1.53	.756	.796	5.03	8.76	3.20	1.61	1.06	.799	.759	2.19
1920-21	1.75	.790	6.21	2.02	1.37	6.74	3.75	3.38	.729	.735	.964	.357	2.42

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Otter Brook near Keene, N. H.

(Drainage area, 39.5 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1923-24	.762	2.46	3.80	2.73	1.28	1.48	8.03	3.06	.608	.314	.149	.658	2.11
1924-25	.264	.352	.980	.147	3.24	5.32	3.17	1.28	.514	.317	.227	.322	1.33
1925-26	.380	1.24	2.49	1.47	.628	1.10	4.99	1.98	.866	.787	.289	.273	1.37
1926-27	.823	2.84	1.58	1.27	.987	4.30	2.63	1.98	1.05	.663	.585	.446	1.60
1927-28	1.19	5.09	3.24	1.82	1.69	2.71	3.49	3.57	3.06	1.19	1.91	1.60	2.56
1928-29	.830	.939	.729	.916	.476	5.34	6.48	4.35	.922	.461	.183	.299	1.84

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

South Branch of Ashuelot River at Webb, near Marlboro, N. H.

(Drainage area, 36.6 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1920-21	—	—	4.29	1.46	.874	4.73	2.87	1.70	.350	.527	.211	.107	—
1921-22	.253	.574	1.88	1.30	1.00	4.21	5.14	1.98	3.50	2.07	.902	.680	1.98
1922-23	.762	.978	.667	2.18	.680	1.90	6.69	2.26	.689	.303	.180	.374	1.47
1923-24	.817	2.48	3.93	3.06	1.04	2.07	6.17	2.35	.557	.145	.095	.740	1.95
1924-25	.331	.295	1.16	.174	3.91	5.22	2.71	1.22	.511	.290	.181	.133	1.33
1925-26	.404	1.25	2.64	1.68	.727	1.38	5.30	1.45	.618	.303	.160	.086	1.33
1926-27	.423	2.32	1.46	1.01	.751	4.26	1.84	1.79	.831	.557	.923	.434	1.39
1927-28	1.25	6.67	4.07	1.87	1.19	1.87	2.81	3.25	2.60	2.06	3.58	3.36	2.87
1928-29	.948	1.01	1.33	2.65	1.62	6.89	6.58	4.23	.839	.233	.117	.144	2.22

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Millers River near Winchendon, Mass.

(Drainage area, 80 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1916	—	—	—	—	—	—	—	—	2.55	1.25	.722	1.19	—
1916-17	.740	.672	1.00	.986	.768	—	—	—	2.20	.910	1.35	.865	—
1917-18	.871	1.07	.784	.555	1.55	4.06	4.31	1.44	1.21	.781	.694	.995	1.52
1918-19	.700	1.04	1.46	1.99	1.16	3.66	3.33	4.10	1.20	.946	.734	1.04	1.79
1919-20	.729	1.94	1.79	.759	.566	4.96	7.96	3.08	1.81	.916	1.01	.811	2.20
1920-21	1.40	1.66	4.00	1.49	1.53	4.12	3.76	2.91	.824	1.05	.934	.542	2.02
1921-22	.514	.958	1.71	.646	.870	3.91	5.00	2.36	3.55	2.51	1.45	1.28	2.06
1922-23	.888	.711	.720	2.14	1.70	3.19	5.81	2.80	.935	.746	.809	.470	1.74
1923-24	.514	1.17	2.28	2.96	1.38	1.55	5.98	2.58	.898	.479	.565	.526	1.74
1924-25	.300	.350	.612	.289	2.28	3.01	2.78	1.20	.755	1.36	.690	.656	1.18
1925-26	.925	1.39	2.12	1.46	2.30	2.68	4.75	1.48	.956	.725	.554	.278	1.62
1926-27	.425	1.60	1.06	1.23	1.60	3.92	2.14	1.82	.988	.748	1.14	1.08	1.48
1927-28	1.42	3.78	4.00	2.38	2.18	1.82	2.66	2.66	2.74	2.28	3.11	2.48	2.62

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Millers River at Erving, Mass.

(Drainage area, 372 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1914	—	—	—	—	—	—	—	—	—	—	.430	.336	—
1914-15	.320	.277	.222	1.75	2.72	1.42	1.87	1.39	.511	1.99	2.27	.618	1.27
1915-16	.653	.656	1.70	2.48	2.69	2.72	5.19	2.36	2.26	1.53	.941	1.25	2.03
1916-17	.965	.981	1.50	1.47	.944	4.01	3.47	2.23	2.23	1.03	1.09	.860	1.74
1917-18	.841	1.24	.656	.478	1.43	3.68	4.17	1.60	1.19	.597	.403	.788	1.42
1918-19	.806	.962	1.78	1.88	.906	3.76	2.96	3.28	.831	.688	.422	.823	1.60
1919-20	.591	2.06	2.08	.720	.444	5.08	7.45	3.31	2.01	.817	.919	.675	2.18
1920-21	1.28	1.56	4.15	1.98	1.07	4.30	3.92	3.39	.782	1.47	.761	.414	2.10
1921-22	.409	.922	1.88	.882	1.22	4.14	5.13	2.74	4.41	2.90	1.13	1.23	2.25
1922-23	.887	.922	.925	2.37	1.76	2.98	5.22	2.66	.849	.430	.352	.245	1.63
1923-24	.422	1.17	2.54	2.96	1.37	1.77	5.78	2.32	.823	.374	.301	.511	1.69
1924-25	.298	.368	.718	.224	2.15	3.28	2.74	1.34	.788	1.05	.702	.565	1.18
1925-26	.777	1.43	2.02	1.48	1.04	1.99	4.57	1.44	.742	.465	.344	.255	1.38
1926-27	.446	1.72	1.12	.707	1.01	4.25	1.75	1.79	1.02	.766	1.09	.785	1.37
1927-28	1.20	4.35	3.98	2.34	1.98	1.86	2.72	2.26	2.61	1.88	2.82	2.61	2.55

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Sip Pond Brook near Winchendon, Mass.

(Drainage area, 18.8 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1916	—	—	—	—	—	—	—	1.53	2.05	1.32	.862	1.33	—
1916-17	1.16	1.02	1.53	1.47	.979	3.97	3.98	2.19	2.27	.941	2.31	1.39	1.94
1917-18	.872	1.41	.984	.718	1.04	3.82	5.00	1.47	1.26	.691	.499	1.22	1.58
1918-19	1.00	1.01	1.98	1.88	1.07	3.30	3.35	4.19	.862	.301	.104	.495	1.63
1919-20	.488	1.84	1.99	.888	.532	5.29	8.62	3.32	1.53	.523	.564	.404	2.17
1920-21	1.23	1.42	4.63	1.54	.872	3.72	3.80	2.73	.508	.649	.271	.144	1.80
1921-22	.195	.606	1.05	.638	.766	3.79	5.48	2.12	3.72	3.03	.973	1.20	1.96
1922-23	1.13	1.24	.654	1.52	1.22	1.84	6.06	2.39	.761	.508	.446	.169	1.49
1923-24	.387	1.51	3.09	2.83	1.20	1.64	6.06	2.39	.702	.062	.036	.289	1.68
1924-25	.108	.198	.601	.143	2.62	4.53	3.24	1.36	.734	.782	.495	.216	1.24
1925-26	.410	1.28	1.70	.973	.819	1.52	5.90	1.74	.734	.430	.385	.290	1.35
1926-27	.438	2.25	1.15	1.29	1.17	4.37	2.15	2.05	1.10	.729	.942	.878	1.54
1927-28	1.19	4.11	3.46	2.13	1.52	1.78	3.14	2.93	2.40	1.82	3.01	2.93	2.53

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Priest Brook near Winchendon, Mass.

(Drainage area, 18.8 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1916	—	—	—	—	—	—	—	1.42	2.19	1.66	.755	1.60	—
1916-17	1.14	1.26	1.60	1.32	.628	4.47	3.98	1.89	2.52	.633	2.12	1.19	1.90
1918	—	—	—	—	—	—	—	—	—	.410	.112	1.14	—
1918-19	1.10	1.07	2.98	1.96	.686	6.28	3.56	4.49	.771	.247	.105	.387	1.98
1919-20	.463	2.60	1.97	.356	.431	7.13	9.52	3.47	1.99	.553	1.59	.713	2.56
1920-21	2.36	1.94	5.04	1.61	.782	4.82	3.93	2.95	.617	.497	.118	.075	2.07
1921-22	.284	1.36	1.62	.644	.984	4.59	5.85	2.99	5.69	3.32	1.03	.835	2.43
1922-23	.681	.734	.479	1.90	1.22	2.61	7.02	2.94	.638	.250	.191	.104	1.56
1923-24	.569	2.73	4.39	3.08	.819	1.50	7.07	2.60	.457	.087	.062	.314	1.97
1924-25	.156	.286	.387	.065	2.63	4.55	3.26	1.26	.729	.542	.270	.193	1.19
1925-26	.548	1.22	2.05	1.18	.697	2.15	6.06	1.35	.537	.201	.157	.092	1.35
1926-27	.543	2.49	1.10	1.05	.771	4.59	1.95	2.32	.894	.606	1.07	.681	1.51
1927-28	1.51	6.60	3.45	2.03	1.37	1.99	3.43	3.06	2.73	2.45	3.66	2.89	2.93

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

East Branch of Tully River, near Athol, Mass.

(Drainage area, 50.2 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1916	—	—	—	—	—	—	—	—	2.87	1.53	.835	1.50	—
1916-17	.996	1.07	1.66	1.62	.769	3.80	3.90	2.05	2.41	.622	1.69	1.18	1.82
1917-18	1.00	1.67	.707	.512	1.28	4.34	5.40	1.67	1.16	.396	.140	1.13	1.61
1918-19	.936	1.25	2.61	2.55	1.02	4.88	3.37	3.31	.566	.279	.092	.508	1.79
1919-20	.526	2.85	2.51	.456	.472	5.84	8.37	3.39	1.60	.588	1.25	.480	2.37
1920-21	1.54	1.55	4.76	1.85	.805	5.06	3.98	2.93	.335	.876	.301	.086	2.01
1921-22	.301	.972	2.09	.861	1.06	5.12	5.34	2.51	4.86	3.05	1.04	.922	2.35
1922-23	.669	.773	.444	2.09	1.17	2.71	5.90	2.63	.484	.315	.213	.101	1.46
1923-24	.526	1.73	3.51	2.85	.884	1.70	5.78	2.31	.494	.114	.098	.594	1.71
1924-25	.219	.436	.884	.199	3.07	4.42	3.15	1.41	.679	.667	.329	.211	1.29
1925-26	.534	1.55	1.77	1.50	.972	2.69	5.44	1.49	.600	.188	.112	.066	1.41
1926-27	.404	2.15	1.17	1.24	.984	5.00	1.90	2.17	.869	.584	.863	.466	1.49
1927-28	1.23	5.36	3.71	2.25	1.51	1.90	3.01	2.87	2.89	2.37	3.75	2.75	2.79
1928-29	.721	.693	.857	1.39	1.03	4.96	4.44	3.39	.970	.255	.091	.058	1.58

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Moss Brook at Wendell Depot, Mass.

(Drainage area, 12.2 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1909	—	—	—	—	—	—	—	—	.718	.227	.271	.366	—
1909-10	.274	—	—	—	—	—	3.18	1.16	.629	.109	.165	—	—
1916	—	—	—	—	—	—	—	—	1.89	.918	.379	.560	—
1916-17	.574	.975	1.43	1.47	1.05	3.55	3.20	2.34	2.59	.650	.459	.280	1.55
1917-18	.820	.976	.571	.427	1.48	3.89	4.36	1.70	.804	.265	.118	.566	1.33
1918-19	.430	.680	2.09	1.96	1.10	4.58	3.16	3.48	.606	.535	.217	.693	1.64
1919-20	.545	2.18	2.37	.564	.649	4.89	7.49	4.19	2.38	.918	.641	.509	2.28
1920-21	1.16	1.65	5.00	3.13	1.26	4.66	4.12	3.93	1.08	1.79	.637	.195	2.40
1921-22	.425	1.60	3.85	.761	1.15	5.93	5.39	3.41	4.68	2.93	1.09	1.12	2.70
1922-23	.786	1.10	.607	1.91	8.28	3.20	5.70	2.93	.762	.418	.205	.180	1.55
1923-24	.734	2.20	3.87	4.14	1.04	2.16	5.21	2.47	.579	.214	.187	.801	1.97
1924-25	.384	.521	1.36	.230	3.65	5.36	3.11	1.34	.650	.693	.379	.323	1.48
1925-26	.734	1.69	3.00	1.39	.801	2.15	4.68	1.25	.567	.307	.273	.109	1.41
1926-27	.493	1.89	1.16	1.44	1.08	6.29	2.05	2.70	1.08	.877	.836	.420	1.70
1927-28	1.40	6.70	3.70	2.38	1.67	1.98	4.18	3.26	4.28	2.02	3.15	2.37	3.08

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Deerfield River at Charlemont, Mass.

(Drainage area, 362 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1913	—	—	—	—	—	—	—	—	—	.285	.220	.475	—
1913-14	1.64	3.62	1.81	1.07	.859	3.95	12.2	3.84	.503	.691	.674	.180	2.59
1914-15	.282	.580	.439	2.36	4.20	1.50	4.81	1.25	.348	4.70	3.51	1.28	2.09
1915-16	1.36	1.92	3.12	3.81	3.26	2.09	8.51	4.25	2.65	1.52	.511	.856	2.79
1916-17	.823	2.09	1.77	1.33	1.12	3.62	7.24	4.36	2.75	.746	.765	.387	2.25
1917-18	2.11	1.05	.671	.599	2.17	4.36	7.57	2.85	1.31	.312	.290	1.18	2.03
1918-19	1.60	1.77	2.82	1.68	.500	5.99	4.70	5.97	.702	.412	.555	2.33	2.43
1919-20	2.10	4.25	2.37	.384	.359	6.30	9.50	3.15	2.62	1.11	.903	.890	2.82
1920-21	1.63	2.30	4.89	1.72	1.29	10.9	3.81	2.50	.898	1.71	.594	.271	2.74
1921-22	.591	1.98	2.25	1.04	1.36	6.13	9.48	4.12	3.54	.619	.914	.564	2.71
1922-23	.533	.854	.597	1.90	.986	3.01	9.89	2.76	1.47	.483	.345	.635	1.95
1923-24	2.87	2.73	4.78	3.29	.746	1.43	8.87	5.77	.724	.293	.262	.771	2.72
1924-25	.800	1.30	1.64	.453	4.34	5.97	4.17	2.01	1.20	1.56	.666	1.15	2.09
1925-26	1.76	4.27	3.03	1.08	.624	1.58	8.63	4.01	1.36	.403	.298	.467	2.29
1926-27	1.43	3.84	1.20	1.20	1.11	6.35	3.90	2.64	1.38	.964	.945	.845	2.15
1927-28	2.35	8.95	5.06	3.40	2.36	2.93	6.63	5.28	3.76	2.33	2.93	1.59	3.95
1928-29	.782	.989	1.40	1.86	.831	8.07	9.61	4.94	.876	.409	.177	.254	2.52

NOTE. — Corrected for storage.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Ware River at Gibbs Crossing, Mass.

(Drainage area, 201 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1912	—	—	—	—	—	—	—	—	—	—	.343	.209	—
1912-13	.239	.517	.836	1.83	.960	3.94	3.88	1.53	.731	.330	.300	.373	1.29
1913-14	.826	.955	1.21	.920	1.35	4.54	4.56	2.78	.562	.498	.338	.208	1.57
1914-15	.149	.171	.302	2.05	2.61	1.12	1.19	.776	.323	1.21	2.07	.478	1.03
1915-16	.435	.537	1.76	2.14	2.25	2.82	5.57	2.76	2.47	1.96	1.12	.557	2.02
1916-17	.471	.582	.975	1.25	1.20	4.57	3.08	2.21	1.98	.791	.430	.350	1.49
1917-18	.537	.821	.697	.542	1.45	3.70	2.82	1.44	.920	.457	.344	.930	1.22
1918-19	.846	.950	1.62	2.00	1.18	4.54	3.56	2.80	.900	.701	.430	1.57	1.76
1919-20	.821	2.68	2.38	1.01	.871	5.72	5.08	2.83	1.95	.871	.572	.423	2.11
1920-21	1.07	1.69	3.59	1.89	1.11	3.50	3.32	2.75	.647	1.90	.687	.374	1.89
1921-22	.362	.930	1.92	.930	1.02	4.08	4.19	2.30	2.84	2.92	.980	1.01	1.96
1922-23	.841	.796	.508	2.42	1.08	3.92	4.68	2.33	.816	.367	.315	.245	1.53
1923-24	.440	1.04	2.33	2.74	.935	1.81	5.27	2.13	.826	.362	.403	.454	1.56
1924-25	.273	.333	.861	.355	1.81	3.12	2.38	1.19	.657	.557	.393	.435	1.02
1925-26	.721	1.33	1.90	1.25	2.22	2.78	3.95	1.29	.617	.331	.306	.230	1.40
1926-27	.388	1.39	.905	1.97	1.57	4.00	1.59	1.78	.876	1.00	1.89	1.37	1.56
1927-28	1.47	3.67	3.70	2.15	2.23	1.66	2.77	2.53	2.66	1.78	1.64	1.55	2.32
1928-29	.864	.724	.930	1.33	1.27	4.30	4.44	3.16	.839	.366	.270	.305	1.57

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Swift River at West Ware, Mass.

(Drainage area, 186 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1912-13	.285	.575	.715	2.02	1.15	3.60	3.34	1.64	.871	.312	.227	.310	1.25
1913-14	.672	.704	1.06	.753	1.28	3.61	4.58	2.83	.774	.602	.419	.285	1.46
1914-15	.219	.306	.312	1.75	2.62	1.37	1.70	1.20	.422	1.89	2.93	.651	1.27
1915-16	.683	.731	1.83	2.31	2.24	2.88	5.30	2.38	2.19	1.60	.995	.995	2.01
1916-17	.909	.989	1.45	1.26	.925	3.47	3.15	2.14	2.04	.909	.634	.651	1.55
1917-18	.634	1.06	.747	.586	1.41	3.89	3.35	1.48	1.02	.528	.405	.683	1.31
1918-19	.688	.860	1.59	1.93	1.05	3.84	3.74	3.18	1.30	.790	.608	1.31	1.74
1919-20	.801	2.22	2.48	.952	.920	5.24	5.75	3.15	2.34	1.06	.968	.683	2.22
1920-21	1.27	1.72	3.82	2.01	1.11	3.48	3.81	3.68	.995	2.15	1.05	.624	2.16
1921-22	.618	1.16	2.10	.882	1.18	3.52	3.86	2.55	3.75	3.24	1.15	1.21	2.11
1922-23	1.08	1.03	.839	2.32	1.32	2.81	5.08	3.16	1.16	.548	.500	.378	1.68
1923-24	.651	1.34	3.20	3.27	1.26	1.76	4.39	2.24	.919	.470	.412	.462	1.70
1924-25	.322	.356	.602	.266	2.35	2.88	2.38	1.32	.753	.839	.699	.737	1.12
1925-26	.876	1.34	1.87	1.73	1.20	2.46	3.93	1.44	.753	.478	.453	.351	1.41
1926-27	.543	1.60	1.13	1.76	1.49	3.63	1.70	1.81	1.07	1.05	1.46	1.02	1.53
1927-28	1.35	3.91	3.73	2.46	2.21	1.91	2.91	2.50	3.10	1.70	1.81	1.84	2.45
1928-29	.866	.812	.909	1.43	1.26	3.83	3.90	3.28	.941	.529	.287	.320	1.53

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Quaboag River at West Brimfield, Mass.

(Drainage area, 150 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1912	—	—	—	—	—	—	—	—	—	—	.347	.293	—
1912-13	.247	.467	.753	1.84	1.19	3.06	4.55	1.63	.900	.349	.267	.315	1.29
1913-14	.605	.953	1.27	.980	1.17	3.87	4.27	3.25	.707	.733	.459	.300	1.55
1914-15	.230	.284	.407	3.52	2.89	1.63	1.15	.767	.423	.827	1.19	.482	1.14
1915-16	.673	.660	1.25	2.13	2.03	3.20	5.09	2.46	2.17	1.61	1.67	.887	1.99
1916-17	.707	.693	.940	1.33	1.23	3.87	3.34	1.82	1.70	.713	.609	.557	1.46
1917-18	.574	.833	.573	.568	1.41	4.04	2.60	1.37	.860	.540	.427	.479	1.19
1918-19	.707	.733	1.07	1.89	1.35	4.26	3.44	2.43	.947	.907	.584	1.83	1.68
1919-20	1.27	2.38	2.47	1.04	.893	6.11	5.77	3.53	2.45	1.35	.953	.740	2.42
1920-21	1.35	1.41	3.55	2.01	1.32	3.63	2.79	3.00	.626	1.17	.693	.407	1.84
1921-22	.421	.643	1.75	.880	1.10	3.98	4.13	2.47	1.40	1.93	1.15	1.53	1.78
1922-23	1.03	1.01	.584	2.62	1.03	3.87	4.90	2.89	1.08	.593	.590	.300	1.71
1923-24	.455	.953	2.65	3.91	1.55	2.27	5.78	2.22	.953	.380	.454	.529	1.84
1924-25	.341	.341	.820	.364	2.01	2.89	1.95	1.24	.693	.485	.445	.326	.987
1925-26	.520	.760	1.48	1.09	.940	2.52	3.59	1.40	.593	.259	.297	.220	1.14
1926-27	.335	.906	.793	1.23	1.89	3.34	1.64	1.53	.840	.641	1.79	1.60	1.37
1927-28	1.61	3.52	4.00	2.38	2.87	1.83	2.12	2.43	2.30	1.47	1.26	1.42	2.26
1928-29	.893	.840	.867	1.47	1.32	3.62	4.05	3.56	.847	.445	.327	.331	1.55

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Westfield River at Knightville, Mass.

(Drainage area, 162 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1909	—	—	—	—	—	—	—	—	—	—	.183	.464	—
1909-10	.407	.369	.660	3.54	1.59	7.41	3.54	1.51	2.19	.274	.220	.557	1.86
1910-11	.149	.871	.529	1.24	.457	1.60	4.00	1.33	1.58	.245	.375	.522	1.07
1911-12	2.85	2.54	2.41	1.61	1.68	6.30	6.30	2.60	1.09	.163	.259	.269	2.34
1912-13	1.19	2.44	2.35	3.97	1.31	5.33	3.75	1.51	.482	.128	.097	.293	1.91
1913-14	1.20	2.35	1.96	2.41	1.96	4.63	7.84	3.09	.435	.352	.331	.118	2.22
1914-15	.144	.336	.423	2.25	3.59	1.60	2.81	1.03	.376	2.38	3.07	.852	1.56
1915-16	.957	1.09	2.49	3.51	3.30	2.69	7.16	2.46	1.87	1.15	.568	.722	2.32
1916-17	.534	1.22	1.34	1.64	.852	3.98	4.84	3.10	3.29	.877	.239	.167	1.84
1917-18	.969	.858	.567	.654	1.90	5.09	4.60	1.83	.802	.377	.170	.654	1.53
1918-19	.594	1.07	2.16	1.43	.728	4.65	3.42	5.00	.790	.603	.435	1.07	1.84
1919-20	.870	2.94	1.76	.532	.401	6.67	8.70	2.26	1.97	.654	.753	.430	2.33
1920-21	1.61	2.57	4.82	1.73	1.07	6.85	4.21	2.23	.461	.895	.342	.204	2.27
1921-22	.279	1.14	2.09	.545	.864	5.70	6.91	3.77	3.32	.926	.846	.735	2.27
1922-23	.717	.698	.529	1.69	.926	3.04	6.48	2.41	1.20	.382	.246	.377	1.56
1923-24	1.90	2.04	3.75	3.23	.932	2.15	9.01	3.70	.877	.324	.262	.944	2.43
1924-25	.852	1.42	1.30	.486	4.12	4.75	3.05	1.45	.667	1.88	.957	.441	1.77
1925-26	.716	3.40	3.00	1.42	.741	2.36	7.41	1.93	.722	.367	.436	.240	1.89
1926-27	.784	2.80	1.22	1.73	1.51	6.15	2.30	2.18	1.19	.630	.833	.735	1.84
1927-28	2.48	6.73	4.38	2.33	2.36	2.41	4.29	3.86	4.00	2.34	2.74	1.94	3.31
1928-29	.533	.536	.778	1.11	.858	6.42	7.04	3.25	.630	.189	.144	.194	1.81

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Westfield River near Westfield, Mass.

(Drainage area, 496 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1914	—	—	—	—	—	—	—	—	—	.458	.496	.224	—
1914-15	.262	.409	.449	2.08	3.49	1.48	2.40	1.16	.504	1.84	2.40	.704	1.42
1915-16	.756	1.01	2.12	3.02	2.60	2.44	5.77	2.04	1.85	1.22	.647	.770	2.01
1916-17	.627	1.03	1.40	1.50	.990	3.73	4.05	2.70	2.70	.938	.468	.411	1.71
1917-18	1.12	.974	.637	.754	2.06	4.68	3.91	1.77	.845	.552	.369	.774	1.53
1918-19	.633	.911	1.58	1.62	.786	3.91	3.06	4.25	.919	.643	.528	.976	1.66
1919-20	.692	2.36	1.85	.772	.659	5.50	7.40	2.30	2.01	.980	1.18	.679	2.20
1920-21	1.48	2.38	4.42	1.75	1.18	5.42	3.53	1.98	.565	.849	.500	.339	2.04
1921-22	.365	.671	1.22	.627	.940	4.68	4.84	3.53	2.46	1.32	1.01	.772	1.87
1922-23	.746	.643	.518	1.86	1.04	3.39	5.24	2.36	1.08	.464	.345	.403	1.51
1923-24	1.72	1.58	3.10	3.06	.972	1.84	6.65	3.23	.942	.460	.387	.808	2.06
1924-25	.764	1.17	1.30	.532	3.47	3.91	2.36	1.49	.728	1.00	.808	.526	1.49
1925-26	.758	1.90	2.34	1.43	1.06	2.24	5.62	1.64	.792	.423	.738	.544	1.62
1926-27	.947	2.56	1.29	1.48	1.56	4.92	1.95	2.06	1.31	.879	1.68	1.25	1.82
1927-28	2.56	6.77	4.21	2.30	2.60	2.46	3.95	3.39	3.39	2.22	3.06	2.14	3.25

NOTE. — Discharge corrected for diversion from Westfield Little River.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Middle Branch of Westfield River at Goss Heights, Mass.

(Drainage area, 53 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1910	—	—	—	—	—	—	—	—	—	.148	.213	.508	—
1910-11	.127	1.04	.567	1.32	.472	3.33	4.98	1.48	1.59	.251	.394	.692	1.35
1911-12	5.38	2.72	2.85	1.64	1.63	7.79	6.62	3.30	.851	.100	.200	.443	2.79
1912-13	.974	2.43	2.91	3.45	1.36	4.98	3.87	1.34	.481	.116	.071	.223	1.86
1913-14	1.41	3.38	2.62	2.40	1.92	4.55	8.42	3.38	.266	.129	.140	.028	2.38
1914-15	.089	.230	.340	3.55	4.34	1.14	2.30	.774	.074	1.98	2.34	.257	1.44
1915-16	.287	.334	3.00	3.98	3.49	2.89	7.83	2.28	1.80	.653	.345	.472	2.26
1916-17	.436	1.35	1.37	1.65	.862	3.85	4.49	2.47	2.60	.445	.149	.129	1.65
1917-18	.655	.460	.372	.447	1.98	6.23	4.34	1.66	.506	.309	.167	.491	1.46
1918-19	.398	.826	2.70	1.84	1.00	4.94	3.38	4.74	.587	.596	.362	1.16	1.89
1919-20	.798	3.26	2.11	.381	.326	6.60	8.33	2.27	2.09	.623	1.11	.679	2.38
1920-21	1.61	3.21	5.30	2.08	1.37	8.94	4.66	2.23	.555	.636	.343	.312	2.62
1921-22	.326	.975	2.40	.694	.979	5.74	5.68	4.38	2.49	.883	.798	.553	2.17
1922-23	.694	.715	.528	2.15	.994	2.64	6.26	2.28	.996	.245	.102	.191	1.48
1923-24	1.51	2.23	3.94	3.79	1.00	2.04	6.58	2.85	.634	.240	.279	.864	2.17
1924-25	.675	1.33	1.50	.502	4.51	4.85	2.49	1.30	.387	.809	.492	.270	1.58
1925-26	.557	2.30	2.72	1.42	1.17	3.93	6.79	1.28	.408	.212	.304	.170	1.77
1926-27	.591	2.74	.843	1.11	.823	5.55	1.74	1.98	.945	.740	1.09	1.05	1.60
1927-28	3.62	6.91	4.77	2.21	2.19	2.51	4.15	3.62	3.49	2.34	3.17	2.28	3.43

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Westfield Little River near Westfield, Mass.

(Drainage area, 43 square miles in 1905-1909; 48 square miles in 1910-1922)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1905	—	—	—	—	—	—	—	—	—	—	.953	3.16	—
1905-06	1.02	1.21	—	—	—	—	6.70	1.73	1.10	.628	.405	.209	—
1906-07	.998	1.34	1.90	3.28	1.21	3.95	2.72	2.09	2.16	.323	.131	1.88	1.83
1907-08	5.63	5.16	4.44	3.84	3.28	6.79	3.12	4.19	.637	.437	.328	.133	3.16
1908-09	.233	.274	.828	1.85	5.35	4.35	6.00	2.42	.679	.184	.309	.218	1.86
1909-10	.235	.268	1.09	—	—	—	—	1.16	1.94	.256	.256	.170	—
1910-11	.035	.815	.319	1.05	.440	1.94	3.83	1.30	1.65	.331	.496	1.31	1.12
1911-12	5.17	2.77	2.35	1.58	2.85	7.35	5.21	3.17	.900	.130	.240	.358	2.67
1912-13	.752	1.98	2.40	3.48	1.03	4.34	2.75	1.87	.435	.050	.074	.170	1.62
1913-14	2.08	2.39	1.64	1.19	1.37	4.83	6.52	2.29	.273	.275	.112	.049	1.92

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE—*Concluded**Westfield Little River near Westfield, Mass.—Concluded*

(Drainage area, 43 square miles in 1905–1909; 48 square miles in 1910–1922)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1914–15	.108	.869	.360	3.71	5.23	1.07	2.92	1.69	.729	2.33	2.17	.425	1.79
1915–16	.594	.894	2.90	2.77	2.60	1.85	7.46	1.94	2.15	1.54	.427	.765	2.15
1916–17	.554	1.08	1.39	1.75	1.03	2.96	5.39	3.06	2.07	.442	.269	.227	1.69
1917–18	1.15	.735	.499	.683	2.29	5.58	3.22	1.19	.636	.182	.234	.658	1.42
1918–19	.381	.847	1.88	1.45	.676	4.81	4.37	4.60	.454	.394	.315	.623	1.74
1919–20	.474	2.41	1.91	.542	.565	6.91	7.88	2.23	2.70	1.01	1.45	.786	2.41
1920–21	1.59	3.48	6.04	1.94	1.15	7.03	4.70	2.04	.423	.808	.464	.272	2.52
1921–22	.139	.654	1.02	.351	.610	5.40	5.20	4.64	2.12	1.44	1.12	.757	1.96
1922–23	.635	.555	.476	1.79	1.21	4.35	6.52	2.76	1.14	.212	.190	.342	1.68
1923–24	2.06	1.95	3.53	3.36	.845	1.77	9.05	3.30	.654	.231	.134	.516	2.29
1924–25	.497	.938	1.21	.338	4.23	4.74	2.52	1.50	.542	.971	.557	.254	1.51
1925–26	.623	1.79	2.95	1.53	1.44	2.82	6.74	1.59	.503	.295	.633	.245	1.76
1926–27	.656	2.62	1.93	3.36	1.82	5.20	1.55	2.41	1.56	.608	2.99	1.83	2.23
1927–28	3.53	8.25	4.02	2.35	3.84	2.33	5.05	2.85	3.07	2.25	3.67	1.76	3.57

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Farmington River near New Boston, Mass.

(Drainage area, 92.7 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1913	—	—	—	—	—	—	—	3.10	1.04	1.18	1.13	.509	—
1913–14	1.47	1.97	1.20	.863	1.40	4.40	5.73	2.80	.895	.978	1.14	.880	1.97
1914–15	.215	.291	.446	2.96	3.44	1.08	2.10	1.24	.768	2.59	2.03	.625	1.47
1915–16	.857	1.01	2.72	3.76	2.58	1.91	6.20	1.88	1.53	1.22	1.19	1.05	2.16
1916–17	1.19	1.40	1.19	1.75	1.28	3.16	3.87	2.00	1.77	.638	1.15	.951	1.69
1917–18	1.07	.534	.335	.430	1.41	4.35	3.29	1.41	.829	.983	1.01	1.25	1.41
1918–19	.580	1.06	1.83	1.42	.501	3.54	3.40	4.43	.721	.787	.949	.967	1.69
1919–20	1.31	2.26	1.77	1.27	1.28	5.76	6.96	1.84	1.67	.889	1.59	1.41	2.33
1920–21	1.77	2.48	4.65	1.93	1.37	4.74	4.10	1.70	.877	.721	.865	.775	2.18
1921–22	.870	.810	1.60	.936	1.39	4.24	4.25	2.99	2.27	1.33	1.12	.973	1.90
1922–23	1.11	.932	1.14	2.46	.768	3.16	5.31	2.54	1.29	.749	.925	.874	1.78
1923–24	1.91	1.36	2.52	3.40	1.65	1.79	6.43	3.19	1.02	.874	.877	1.24	2.19
1924–25	1.13	1.13	1.22	.803	2.87	3.84	2.24	1.41	.740	1.27	.982	.933	1.54
1925–26	1.10	1.48	2.11	1.96	1.32	3.84	6.39	2.08	.841	.772	.984	.880	1.98
1926–27	1.11	2.64	1.06	2.29	2.04	5.63	1.80	2.78	1.56	.795	2.43	1.81	2.17
1927–28	3.39	8.81	4.72	2.93	2.34	2.25	3.58	3.48	3.27	2.20	4.72	2.39	3.68

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Nepaug River near Collinsville, Conn.

(Drainage area: 26.8 square miles, 1912-17; 22.8 square miles, 1917; 23.9 square miles since 1917)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1912	—	—	—	—	—	—	4.35	3.07	.75	.27	.34	.38	—
1912-13	.69	1.42	1.68	2.69	1.39	3.81	3.33	1.90	.60	.23	.28	.58	1.55
1913-14	3.52	2.46	1.84	1.91	1.81	4.62	3.88	2.58	.74	.61	.36	.21	2.04
1914-15	.45	.61	.64	4.17	4.12	1.11	1.56	1.12	.54	.93	2.30	1.02	1.55
1915-16	1.17	1.24	2.30	2.51	3.06	2.44	3.69	1.69	1.44	.88	.39	.56	1.78
1916-17	.48	.74	.74	1.96	.66	4.98	3.16	1.97	2.73	.53	.69	.29	1.58
1917-18	2.49	1.55	1.10	.80	2.90	4.08	2.68	2.44	1.05	.53	.45	.81	1.74
1918-19	.67	1.14	1.93	2.07	1.23	4.79	3.59	3.74	.86	.61	.48	1.06	1.86
1919-20	.76	2.13	1.94	.68	1.39	7.28	4.94	2.59	2.44	1.73	.81	.83	2.29
1920-21	1.55	2.01	3.60	2.09	1.46	4.49	3.61	1.89	.73	1.14	.41	.30	1.94
1921-22	.38	1.04	1.26	.45	1.03	3.92	3.45	2.84	1.24	.92	.90	.70	1.51
1922-23	1.19	.73	.60	2.46	1.15	5.03	4.61	2.35	1.00	.30	.26	.36	1.67
1923-24	1.23	1.02	2.55	—	—	—	—	—	—	—	—	—	—

NOTE. — Records furnished by the Hartford Board of Water Commissioners.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Talcott Mountain Streams at West Hartford, Conn.

(Drainage area, 11.07 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1909	—	—	—	—	—	—	—	—	.548	.034	.229	.227	—
1909-10	.203	.262	.820	4.02	3.27	3.65	2.20	.99	1.22	.21	.15	.15	1.23
1910-11	.09	.37	.59	1.05	1.12	3.26	3.45	.53	.51	.16	.26	.40	.982
1911-12	3.92	2.76	2.14	.45	1.80	4.71	2.48	3.36	.26	.15	.12	.12	1.95
1912-13	.20	.44	1.41	2.25	1.23	4.00	3.10	2.06	.50	.09	.09	.22	1.30
1913-14	3.23	1.67	2.12	1.80	1.21	3.93	3.31	2.15	.37	.34	.22	.06	1.70
1914-15	.19	.56	1.19	4.48	4.41	.97	1.43	.76	.38	.82	3.19	.34	1.56
1915-16	.48	.64	2.76	2.25	3.14	2.94	4.00	1.62	2.17	.91	.85	.43	1.85
1916-17	.35	.77	1.28	1.81	1.01	5.13	2.83	2.18	1.87	.85	.36	.22	1.56

NOTE. — Records furnished by the Hartford Board of Water Commissioners.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Hockanum River near East Hartford, Conn.

(Drainage area, 75.5 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1919-20	.991	1.57	1.61	.977	1.06	5.37	3.12	2.78	2.30	1.64	1.12	1.14	1.97
1920-21	1.22	1.87	2.94	2.20	1.84	3.14	2.56	2.48	1.23	1.52	1.10	.854	1.92
1928-29	.886	.894	.826	1.22	1.72	2.53	3.25	2.90	1.21	.861	1.10	.566	1.50

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Wepawaug River at Orange, Conn.

(Drainage area, 7.7 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1911	—	—	—	—	—	—	—	—	—	.38*	.12	.17	—
1911-12	1.33*	3.43*	2.68	1.47	2.23	—	—	—	.56	.12	.18	.10	—
1912-13	.13	.64	1.06	2.50	1.84	3.45	3.67	1.25	.28*	.08	.03	.14	1.26
1913-14	2.15	1.84	2.25	2.27	1.72	3.31	2.95	1.93	.40	.58	.26	.04	1.64
1914-15	.19	.42	.96	4.23	6.08	1.46	1.00	.78	.24	.52	1.14	.33	1.45
1915-16	.81	.68	2.16	2.29	1.58*	2.79	3.29	2.81	1.87	1.52*	.46*	.14	1.70
1916-17	.32	.50	.77	1.06*	1.31	3.07	2.80*	1.82	1.00	.87	.35	.21	1.17
1917-18	.70	.86	1.00	1.09	5.68	3.08	2.15	1.62	1.00	.36*	.38	.36*	1.52
1918-19	.31	.74*	1.77	2.55	1.67	4.28*	3.59	3.25*	.68	.33	.58	1.76	1.79
1919-20	1.43	2.28	2.46	.92	1.12	6.08	3.81	3.09	1.76	.77	.32	.28	2.03
1920-21	.58	2.46*	4.24*	2.38	1.63	3.13	2.85	2.18	.41	.69	.35	.18	1.76
1921-22	.14	.51	.69	.31	1.36*	2.79	2.33	2.36	1.53	1.58	.32	.21	1.18
1922-23	.26	.26	.33	2.14	.95	4.22	2.62	1.52	.60	.10	.05	.03	1.09
1923-24	1.16	1.50	3.99	3.02	1.13	1.72	5.60	3.42	.65	.13	.23	.14	1.89
1924-25	.20	.10	.32	.37	2.89	2.85	1.45	1.43	.40	.64	1.30	.35	1.02
1925-26	.56	1.38	1.80	.89	2.23	2.60	2.81	.92	.27	.07	.94	.34	1.23
1926-27	.94	3.56	2.00	2.39	2.81	1.95	.82	1.76	.92	.33	3.24	1.25	1.83
1927	1.38	4.87	3.93	—	—	—	—	—	—	—	—	—	—

* Partly estimated.

NOTE. — Data furnished by the New Haven Water Company.

BOSTON SOCIETY OF CIVIL ENGINEERS

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Race Brook at Orange, Conn.

(Drainage area, 2.4 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1911	—	—	—	—	—	—	—	—	—	.27*	.10*	.12	—
1911-12	.83*	3.01*	2.58	1.36	1.37	—	—	—	.39	.06	.04	.03	—
1912-13	.06	.34	.98	2.67	1.50	3.44	3.51	1.12	.24	.04	.03	.04	1.16
1913-14	1.69	2.02	2.07	2.11*	1.57	3.34*	2.63	1.66	.23	.52	.14	.04	1.50
1914-15	.14	.47	1.00	4.05*	4.10*	1.27	.77	.49	.10	.22	.77	.18	1.13
1915-16	.73	.52	1.94*	2.12	1.53*	2.48	2.32	2.00*	1.32	.71*	.13	.08	1.35
1916-17	.12	.24	.82	1.23*	1.31	3.05	2.56*	1.47	1.10	.52	.11	.08	1.05
1917-18	.39	.50	1.01	.88*	4.17*	2.70*	.86	.64	.62	.26*	.40*	.52	1.08
1918-19	.37	.74	1.48	1.94*	1.44	2.95*	2.38*	2.03*	.42	.28	.62	1.80	1.37
1919-20	1.32	1.80	1.73	.78	1.17	4.16*	2.43	1.61	1.17	.45	.23	.18	1.42
1920-21	.36	1.68*	2.60*	1.45	1.20	1.89	1.66	1.23	.02	.39	.31	.15	1.08
1921-22	.10	.60	1.12	.51	1.80	2.40	2.83	2.18	1.96	1.52	.38	.20	1.30
1922-23	.25	.29	.45	2.75	1.15	4.06	2.30	1.22	.36	.10	.02	.01	1.08
1923-24	.76	1.22	3.94	2.93	1.23	1.71	4.42	3.14	.64	.08	.08	.69	1.74
1924-25	.05	1.57	.34	.28	3.28	2.93	1.16	1.08	.28	.46	1.42	.49	1.11
1925-26	.74	1.65	1.93	.98	2.57	2.38	2.24	.62	.20	.05	.47	.32	1.18
1926-27	1.13	2.87	1.68	2.47	2.58	1.79	1.24	1.63	.82	.38	2.88	1.26	1.73
1927	1.66	3.57	3.62	—	—	—	—	—	—	—	—	—	—

* Partly estimated.

NOTE. — Data furnished by the New Haven Water Company.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Housatonic River near Great Barrington, Mass.

(Drainage area, 280 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1913	—	—	—	—	—	—	—	1.95	1.09	.725	.310	.268	—
1913-14	.975	1.44	1.48	.911	.993	4.04	8.18	3.01	.835	.664	.525	.496	1.96
1914-15	.289	.379	.400	1.44	3.41	1.53	2.15	1.10	.493	2.70	1.65	.961	1.36
1915-16	.793	.675	3.01	3.57	2.96	2.34	7.04	1.88	1.28	1.12	.621	.675	2.16
1916-17	.593	.871	1.72	1.80	1.15	4.14	3.86	1.87	1.78	.914	.450	.461	1.64
1917-18	.493	.707	.579	.421	1.60	4.68	3.64	2.04	.954	.511	.439	.618	1.39
1918-19	.625	1.09	2.14	2.14	1.02	3.96	4.04	3.75	1.06	.814	.550	.889	1.85
1919-20	.911	2.91	2.59	1.00	.743	5.68	9.46	2.70	1.32	.950	.864	.714	2.48
1920-21	1.50	2.08	4.54	1.78	1.18	5.11	4.07	1.67	.479	.529	.532	.421	2.00
1921-22	.475	.939	1.80	.832	1.20	4.68	5.79	2.96	3.09	1.30	1.14	1.21	2.12
1922-23	.906	.700	.625	2.08	1.24	3.45	5.29	2.60	1.43	.661	.629	.589	1.68
1923-24	1.41	2.06	3.61	2.95	1.00	1.41	6.79	2.58	1.02	.596	.529	1.12	2.09
1924-25	.875	.914	.850	.596	3.82	3.68	2.77	2.04	.996	.939	.832	.511	1.55
1925-26	.668	2.05	1.69	1.27	.932	2.43	6.68	1.91	.657	.589	.957	.732	1.71
1926-27	1.04	3.24	1.49	1.43	1.72	5.68	1.80	1.97	1.30	.754	.904	.943	1.86
1927-28	1.87	6.71	4.57	3.12	2.81	2.40	3.34	3.71	3.46	2.45	3.35	2.95	3.39
1928-29	.950	.936	1.16	1.22	.700	5.89	6.82	3.93	1.04	.575	.475	.861	2.05

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Housatonic River at Falls Village, Conn.

(Drainage area, 644 square miles)

Year	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1912	—	—	—	—	—	—	—	—	—	.427	.498	.491	—
1912-13	.918	1.83	2.19	3.57	1.94	4.19	3.76	1.42	.832	.300	.244	.281	1.79
1913-14	1.13	1.53	1.42	.797	1.12	3.71	5.93	2.84	.632	.475	.396	.304	1.69
1914-15	.189	.182	.203	1.72	3.15	1.37	1.72	.953	.516	2.22	2.05	.939	1.99
1915-16	.699	.685	2.69	3.52	2.90	2.14	5.64	1.77	1.25	1.38	.691	.697	2.26
1916-17	.602	.753	1.42	1.55	.927	3.26	3.32	1.82	1.60	.877	.444	.359	1.41
1917-18	.430	.700	.539	.385	1.68	4.19	2.89	1.79	.862	.419	.293	.679	1.23
1918-19	.703	.994	1.68	2.00	.882	3.35	3.63	2.82	.904	.680	.365	.623	1.55
1919-20	.565	1.92	2.00	.585	.415	4.52	6.68	2.31	1.33	.790	1.14	.756	1.92
1920-21	1.75	1.83	3.88	1.82	1.17	4.29	3.62	1.52	.576	.567	.516	.373	1.83
1921-22	.371	.854	1.54	.798	1.09	3.68	4.52	2.55	1.94	1.12	.978	.859	1.69
1922-23	.576	.498	.477	1.86	1.20	3.31	3.71	1.96	1.11	.550	.467	.508	1.35
1923-24	1.12	1.72	3.11	2.75	.915	1.19	5.23	2.27	.939	.399	.419	.908	1.74
1924-25	.752	.573	.953	.398	3.42	3.32	2.33	1.45	.761	.890	.755	.500	1.33
1925-26	.618	1.60	1.35	1.27	1.16	2.87	4.49	1.54	.661	.391	.686	.557	1.43
1926-27	.949	2.58	1.31	1.57	1.80	4.52	1.60	1.81	1.07	.550	1.44	1.18	1.70
1927-28	2.08	5.90	3.96	2.05	2.50	1.77	2.70	2.39	2.56	2.08	3.22	2.03	2.76
1928-29	.705	.553	.635	.995	.817	4.24	5.14	2.64	.657	.371	.244	.250	1.44

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Housatonic River at Gaylordsville, Conn.

(Drainage area, 1,020 square miles)

[illegible]

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Ten Mile River near Dover Plains, N. Y.

(Drainage area, 195 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1901-02	1.19	.918	3.85	2.64	1.72	6.29	2.57	1.58	.692	1.24	.733	.774	2.02
1902-03	1.86	1.15	3.99	2.56	3.53	4.80	2.58	.482	3.22	1.52	1.60	1.13	2.37
1903	3.31	—	—	—	—	—	—	—	—	—	—	—	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Pomeraug River at Bennetts Bridge, Conn.

(Drainage area, 89.3 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1913-14	2.23	2.45	1.94	1.15	.559	3.75	2.64	2.04	.568	.608	3.90	.183	1.57
1914-15	.423	.455	.458	—	—	1.40	1.43	1.05	.403	.678	1.55	.823	—
1915-16	.877	.826	2.52	2.60	2.51	3.17	3.99	1.53	1.51	.907	.488	.403	1.78
1916	.381	.502	.732	—	—	—	—	—	—	—	—	—	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Naugatuck River near Naugatuck, Conn.

(Drainage area, 247 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1918	—	—	—	—	—	—	—	—	.866	.547	.441	.696	—
1918-19	.567	.907	1.64	1.92	1.27	2.81	2.73	3.26	.818	.652	.482	1.13	1.52
1919-20	.846	2.00	2.08	.907	.866	6.96	4.94	2.88	2.16	1.77	1.08	1.06	2.30
1920-21	1.73	2.13	3.87	2.13	1.69	5.02	3.77	2.23	.563	.802	.382	.349	2.06
1921-22	.338	.761	1.15	.526	1.25	3.32	3.11	2.55	1.39	1.26	.803	.615	1.43
1922-23	.907	.543	.502	2.43	1.26	5.05	3.32	2.21	.99	.522	.377	.405	1.54
1923-24	1.04	1.13	2.63	3.47	1.02	1.94	4.94	2.86	1.19	.429	.453	.470	1.80
1928-29	.668	.640	.943	1.68	2.08	4.02	4.90	3.02	.785	.474	.636	.449	1.69

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

West Branch of Naugatuck River at Wigwam Dam, near Thomaston, Conn.

(Drainage area, 17.8 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1908	—	—	—	3.14	3.55	3.15	1.62	1.81	.528	.184	.183	.070	—
1908-09	.146	.175	.440	1.50	4.39	3.56	5.97	2.26	.460	.081	.136	.118	1.60
1909-10	.122	.238	.797	4.37	2.98	4.92	2.02	1.58	1.96	.169	.260	.121	1.63
1910-11	.063	.700	.764	1.40	1.16	2.64	2.94	.616	.441	.164	.275	.664	.986
1911-12	4.79	2.96	2.02	.896	2.25	5.88	3.09	2.75	.292	.056	.084	.062	2.09
1912	.282	1.02	1.71	—	—	—	—	—	—	—	—	—	—
1923	—	—	—	2.91	1.14	4.61	2.73	1.31	.49	.15	.06	.12	—
1923-24	1.03	1.02	2.99	3.29	.52	1.62	5.92	2.12	.99	.13	.09	.29	1.67
1924	.38	.38	.86	—	—	—	—	—	—	—	—	—	—

NOTE. — Data furnished by the city engineer, Waterbury, Conn.

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Otter Creek at Middlebury, Vt.

(Drainage area, 615 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1903	—	—	—	—	—	—	3.20	.602	.927	.725	.678	.494	—
1903-04	.880	.701	.626	.602	.650	2.76	3.58	2.59	.766	.644	.647	1.07	1.29
1904-05	2.00	.886	.488	.390	.374	1.74	4.80	1.42	1.97	1.47	1.55	2.55	1.64
1905-06	.960	1.02	1.58	2.28	1.16	1.46	5.09	3.04	2.78	1.43	1.20	.685	1.89
1906-07	.810	1.41	.795	1.56	.569	1.69	3.77	—	—	—	—	—	—
1910-11	.629	.930	.813	1.95	.813	1.46	3.90	1.42	.629	.465	.659	.797	1.21
1911-12	1.56	1.42	2.02	.976	.894	2.60	5.90	2.52	1.98	.517	.611	1.03	1.84
1912-13	1.65	2.18	1.62	3.46	1.58	4.11	3.87	1.63	1.07	.507	.416	.414	1.87
1913-14	.883	.909	.946	.722	1.06	2.20	6.67	2.91	.629	.566	.603	.605	1.56
1914-15	.491	.626	.418	1.32	1.90	1.97	1.90	.711	.398	.958	.566	.410	.966
1915-16	.511	.598	1.06	1.97	1.74	1.58	4.98	2.02	1.07	1.12	.554	.473	1.47
1916-17	.563	.802	1.27	1.01	.722	2.03	3.93	1.85	2.05	.540	.515	.460	1.31
1917-18	.854	1.31	.551	.428	1.56	2.94	3.82	2.03	1.05	.649	.462	1.08	1.39
1918-19	1.46	1.98	1.77	1.97	.933	.278	3.41	1.97	.751	.602	.633	1.40	1.64
1919-20	1.29	2.46	1.72	.444	—	—	—	—	—	—	—	—	—
1928-29	.831	.967	.941	.870	.525	3.71	4.31	4.72	1.13	.898	.663	1.15	1.74

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Winooski River at Montpelier, Vt.

(Drainage area, 420 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1914	—	—	—	—	—	—	—	—	—	.350	.231	.300	—
1914-15	.319	.536	.300	.888	.855	1.10	2.20	.945	.495	.910	.705	.307	.795
1915-16	.336	.448	.967	2.01	1.27	1.54	4.24	2.01	1.75	.550	.429	.383	1.32
1916-17	.552	.874	1.11	.655	.438	2.20	5.07	1.89	2.93	.757	.721	.426	1.47
1917-18	1.56	1.01	.564	.374	.817	2.50	4.59	1.84	1.04	.459	.764	1.25	1.40
1918-19	3.14	2.55	1.79	1.25	.586	3.71	4.14	2.45	.745	.331	.267	.698	1.81
1919-20	1.49	1.94	1.37	.600	.521	3.62	6.57	1.98	.526	.690	.617	.933	1.74
1920-21	1.56	1.10	2.55	1.11	.783	5.74	2.15	.605	.381	.331	.374	.143	1.41
1921-22	.386	1.05	1.17	.619	.462	3.62	6.83	1.54	2.35	1.01	.560	.424	1.67
1922-23	.414	.483	.486	.943	.533	1.16	5.86	2.24	.971	.400	.317	.336	1.18
1928-29	.645	.867	.576	.912	.379	3.52	5.05	2.76	1.08	.610	.469	.410	1.44

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Winooski River at Richmond, Vt.

(Drainage area, 985 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1903	—	—	—	—	—	—	—	—	—	.694	.412	.197	—
1903-04	.525	.626	.680	.731	.507	2.00	4.30	2.54	.490	.370	.441	1.05	1.19
1904-05	1.94	.608	.462	.381	.355	4.20	3.22	1.62	1.54	1.64	1.25	2.38	1.64
1905-06	.924	1.24	1.29	2.29	1.20	1.00	5.08	3.28	1.73	.975	.768	.624	1.70
1906-07	.844	1.42	.885	1.39	.500	1.62	5.09	—	—	—	—	—	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Mollys Brook near Marshfield, Vt.

(Drainage area, 24 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1920	—	—	—	—	—	—	—	—	—	—	1.88	2.63	—
1920-21	2.21	1.33	2.62	1.19	.767	5.75	2.73	.862	.567	.471	.410	.143	1.60
1921-22	.471	.975	1.00	.467	.385	3.15	7.83	2.01	2.82	1.57	.767	.800	1.85
1922-23	.729	.679	.558	.946	.608	.875	6.12	2.90	1.08	.675	.671	.488	1.36

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

North Branch of Winooski River at Montpelier, Vt.

(Drainage area, 78 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1909	—	—	—	—	—	—	—	—	.729	.331	.336	.478	—
1909-10	.474	.743	.442	.866	.641	7.22	3.63	2.60	1.83	.479	.615	1.13	1.74
1910-11	1.21	1.47	1.09	1.47	.513	1.03	8.81	1.78	.556	.450	.262	.659	1.60
1911-12	2.06	1.65	4.47	1.41	.769	2.95	9.10	3.78	1.63	.242	.422	1.02	2.46
1912-13	2.19	2.15	1.54	2.56	.961	6.41	3.26	1.41	.522	.195	.078	.112	1.79
1913-14	.603	.744	.751	.449	.385	2.00	10.9	2.41	.259	.415	.313	.600	1.65
1914	.574	1.02	.963	—	—	—	—	—	—	—	—	—	—

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Dog River at Northfield, Vt.

(Drainage area, 47 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1909	—	—	—	—	—	—	—	—	1.44	.256	.195	.202	—
1909-10	.207	.346	.351	—	—	2.56	1.93	1.74	1.73	—	.187	.551	—
1910-11	.596	.900	—	—	—	—	4.66	1.43	.500	.202	.198	.385	—
1911-12	1.32	1.25	1.71	.957	.798	1.25	7.34	3.21	1.82	.270	.245	.538	1.72
1912-13	1.54	2.19	1.62	2.47	.755	6.62	3.53	1.73	.889	.247	.117	.136	1.83
1913-14	.881	1.49	1.38	.543	.489	2.06	10.2	3.17	.568	.506	.270	.262	1.82
1914-15	.300	.649	.568	1.23	2.77	1.62	3.49	1.05	.509	1.46	.947	.347	1.23
1915-16	.400	.487	.777	2.45	1.93	1.96	5.00	2.28	2.06	.902	.389	.313	1.57
1916-17	.443	.894	1.13	.936	.702	2.13	6.83	2.81	3.11	.783	.623	.338	1.72
1917-18	1.35	1.30	.596	.372	.904	2.94	6.06	2.11	.840	.355	.538	1.14	1.54
1918-19	2.72	3.30	2.45	1.83	.834	6.11	5.49	3.40	1.15	.330	.249	.594	2.38
1919-20	1.34	2.32	1.87	.617	.481	7.79	8.94	2.68	.902	.698	.387	.609	2.38
1928-29	5.58	.937	1.06	1.67	.735	4.88	6.75	3.02	.821	.448	.171	.150	1.77

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Missisquoi River near Richford, Vt.

(Drainage area, 445 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1909	—	—	—	—	—	—	—	2.09	.982	.497	.253	.690	—
1909-10	1.44	1.87	1.24	1.46	1.01	5.70	3.77	3.16	2.00	.368	.561	.365	1.92
1910-11	1.45	1.90	—	—	—	—	—	—	—	.238	.272	.676	—
1911-12	1.18	2.31	4.45	1.46	.562	1.69	9.71	3.35	2.94	.124	.710	2.45	2.56
1912-13	2.34	3.37	2.02	2.81	1.26	6.54	3.60	1.29	1.03	.506	.247	.267	2.11
1913-14	.674	1.09	1.24	.506	.404	2.25	6.74	1.77	.195	.276	.240	.613	1.33
1914-15	.658	1.36	1.01	1.24	1.57	2.02	4.25	1.29	.479	.640	.454	.310	1.27
1915-16	.910	1.91	1.51	2.54	2.29	2.06	6.76	2.76	2.63	1.26	.636	.494	2.14
1916-17	2.08	2.07	1.84	1.21	.764	2.29	7.35	3.08	3.10	1.55	1.56	1.02	2.34
1917-18	3.55	2.00	.645	.353	.933	2.43	6.88	2.13	1.60	.816	.661	2.52	2.04
1918-19	4.90	3.62	3.37	2.13	.670	4.36	5.96	2.49	.903	.292	.389	1.96	2.58
1919-20	3.26	4.54	2.40	.472	.346	2.31	—	—	.764	1.92	.483	.847	—
1920-21	1.99	1.92	3.98	1.57	.944	1.91	—	—	.299	.220	.192	.129	—
1921-22	.706	2.04	1.40	.503	.450	.387	6.63	1.36	4.79	1.16	.930	.303	2.01
1922-23	.463	.910	.708	.730	.427	1.31	10.0	3.71	1.77	.467	.254	.447	1.77
1928-29	3.21	2.56	1.78	1.02	.665	6.27	6.85	4.02	1.47	1.26	.445	.472	2.52

MONTHLY MEAN DISCHARGE IN SECOND-FEET PER SQUARE MILE

Clyde River at West Derby, Vt.

(Drainage area, 150 square miles)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Mean for Year
1909	—	—	—	—	—	—	—	—	1.18	.568	.264	.451	—
1909-10	1.06	.893	.833	1.13	.873	3.00	4.56	2.43	2.03	.645	.445	.375	1.52
1910-11	.461	.753	.577	.853	.328	.485	4.45	3.72	.840	.416	.341	.379	1.13
1911-12	.867	.980	2.13	1.30	.600	1.40	6.53	3.01	2.79	.601	.773	1.25	1.85
1912-13	1.27	1.75	1.55	2.23	1.25	5.33	4.43	1.41	1.30	.640	.471	.353	1.83
1913-14	.840	1.00	.840	.618	.607	.913	5.09	3.70	.720	.525	.374	.417	1.31
1914-15	.498	.603	.620	.700	1.23	1.38	2.52	1.66	.867	1.29	.987	.635	1.08
1915-16	.733	.893	.980	1.73	1.59	1.07	4.35	2.80	2.64	1.30	1.18	.627	1.65
1916-17	1.08	1.11	1.81	.873	.624	1.05	5.07	3.33	1.93	1.13	1.86	1.03	1.75
1917-18	2.39	2.77	.853	.512	.787	1.47	5.49	3.43	1.65	1.26	1.23	1.32	1.93
1918-19	3.42	3.73	1.91	1.37	.733	2.10	5.01	3.10	1.21	.840	.713	1.05	2.11
1920	—	—	—	—	—	—	—	2.02	1.05	1.34	.893	1.05	—
1920-21	1.89	1.69	2.51	1.35	.840	4.50	3.63	1.30	.780	.391	.384	.388	1.65
1921-22	.541	1.23	1.31	.707	.497	2.21	7.60	2.37	2.19	1.73	.622	—	—
1922-23	.417	.530	.536	.827	.643	.620	4.97	4.83	1.44	.737	.514	.651	1.39
1923-24	.993	1.68	2.21	1.95	1.05	1.21	4.73	5.42	.800	.847	.987	3.49	2.11

PROF. H. K. BARROWS:*. Mr. Kinnison and I agree in respect to the manner of publication of the stream-flow data of the Geological Survey. It seems to me a mistake to have statistical data of that nature published on the basis of a year beginning the first of October. All such data should, to my mind, begin with the first of January. The idea is perfectly sound that in studies of precipitation and run-off the water year should commence in the fall. On the other hand, some one may wish to begin the year on October 1 and others on the first of November. On the whole, I think it would be very much more convenient for general use and comparison with other statistical data to have the information arranged on a calendar year basis, beginning January 1.

Mr. Kinnison referred briefly to what he did in Vermont in getting flood-flow data at the time of the 1927 flood. I think he is entitled to a great amount of credit for his activity and energy in gathering those data so promptly and so widely after the flood — embracing an opportunity which probably will not occur again for many years. As probably many of you know, he has prepared a report† on that flood which includes a great many measurements of flood flows in New England obtained at that time. It represents a most valuable compilation of data.

There is one other matter which occurred to me as I was looking at the slide which showed the river control. In the early days of the Geological Survey we attempted to do a little work of that nature. We had a station on the Westfield Little River near Blandford, west of Springfield. We were cramped in those days in the matter of funds, but in this instance, by co-operating with the city of Springfield, we were able to do more detailed work. We had a weir installed near the current meter station and succeeded in getting about six months of parallel records. As I recall the results, they showed a rather persistently larger discharge by the current meter records as compared with those based upon the weir readings — about six or eight per cent higher.‡

This was a rough mountain stream, so we thought we would remove some of the worst of the boulders near the section used for the current meter gagings and proceeded to blow them out with dynamite. Inside of a month there was a freshet, and the bed of the stream was rolled

* Professor of Hydraulic Engineering, Massachusetts Institute of Technology, and Consulting Engineer, Boston.

† "The New England Flood of November, 1927" — Water Supply Paper 636-C, United States Geological Survey.

‡ See Water Supply Paper 241, p. 167.

rather more full with boulders than before we started our clearing work. So we discontinued further river improvement.

There are many interesting details in Mr. Kinnison's paper which might be discussed if time permitted.

HOWARD M. TURNER:* I was interested in what Mr. Kinnison said about the daily duration curve as useful for obtaining power estimates. It is true that the use of monthly figures averages on the side of giving too much water in the lower stages. On the other hand, on many of our New England rivers the use of the daily duration curve gives too low an estimate of power on account of the fact that the low flows on Sundays are included as daily flows. Most large power plants, and in fact even small ones, have sufficient mill pondage so that they can store the low flows over the week-end, and the week therefore becomes the significant figure. A duration curve based on average weekly flow gives more accurately an idea of the character of the river for power use than a duration curve based on days.

I have made a brief comparison of the daily and weekly figures of the flow of the Merrimack River at Lawrence for the thirty-five year record from 1880-81 to 1914-15, as shown in the table below:

DAYS OF DEFICIENCY IN DISCHARGE

Discharge in Cubic Feet per Second Measured at Lawrence	Discharge in Cubic Feet per Second per Square Mile Gross Drainage, 4,663 Square Miles	Average Days of Deficiency by Days	Average Days of Deficiency from Weekly Average
800	.172	13.5	—
1,000	.215	15.5	0.057
1,500	.322	24.0	9.20
2,000	.433	45.2	41.40
2,500	.540	83.3	89.0
3,000	.643	122.5	123.10
3,500	.750	150.0	147.20
4,500	.965	190.3	186.50
5,000	1.075	206.0	200.00

Considering a flow of 800 second-feet (.172 cubic feet per second per square mile of gross drainage area) the daily duration curve shows a deficiency below that flow on an average of two weeks per year. The weekly averages, however, show no week during the whole period when

* Consulting Engineer, 12 Pearl Street, Boston, Mass.

the flow was 800 feet or below. In the same way, taking 1,000 cubic feet per second there were only two weeks in the whole thirty-five years of weekly record when the flow reached 1,000 second-feet (.215 cubic feet per second per square mile gross drainage area) or lower, whereas on the daily basis it shows over two weeks average every year. When the flow was 1,500 second-feet (.322 cubic feet per second per square mile gross drainage area) the daily duration curve shows twenty-four days of deficiency, whereas on the weekly basis it shows only nine days.

This discrepancy between the weekly and daily figures decreases as the flows get larger, up to about .5 cubic feet per second per square mile, after which they give about the same results.

Thus, in considering the low flows, which are often of great importance, particularly from a point of view of prime power capacity, the daily duration curve should be used with caution and the week is a more significant period of time on which to base power estimates due to the effect of the mill pond's availability to store the week-end flow over Sundays and distribute it throughout the week, thus evening up the variation in river flow due to Sunday pondage from plants upstream which is reflected in the daily stream-flow records.

Mr. Kinnison's interesting account of the comparison between Professor Allen's measurement of the water used by the Bellows Falls wheels by the salt-solution method and the current-meter measurement, made at the same time, reminds me of another comparison which was made when a water-wheel test was made at Turners Falls on the Connecticut River when that plant was first put in operation in 1916, where the current-meter measurement was compared to a measurement by volume in the forebay and canal above the plant.

The current-meter measurement was made in a flume built in front of the unit to be tested. It was made by the method of integrating in vertical sections, that is, the meter was moved from the surface of the water to the bottom and back again at a uniform rate, thus averaging in its reading the velocities from top to bottom of the traverse. Two improved Fteley-Stearns meters were used, starting at the sides and making vertical traverses every $2\frac{1}{2}$ feet across the flume. The volumetric measurement was made as follows: across the end of the new canal, which was an extension of an old canal, a very tight bulkhead had been built for construction purposes with gates in it. This enabled a length of canal of about 2 miles, with a forebay in its lower end, to be closed off completely, and made it possible to measure the total amount of water used during a given time by the amount the water surface was drawn down. Gauges placed at intervals along the canal were read

during the length of the test, which amounted to about forty minutes, and the area of the canal being known the total amount of water used was figured. Leakage was estimated by closing the gates at the upper end of the canal and measuring the amount that the canal dropped during the night.

The comparison of the two measurements, after all corrections had been made, showed the bulk measurement 3 per cent greater than the current meter in one case, and .5 per cent greater in the other. The test was made in February, which may have affected somewhat the accuracy of the measurement by volume, though I know at the time we felt that the corrections that were applied should adequately cover any questions of ice involved.

EDWARD A. GRAUSTEIN: * I thought Mr. Kinnison's paper was an excellent one and I haven't any comments to make which would improve upon it. There are, however, two things which I would like to mention as very interesting to me.

One is the long-term record of run-off. Some of our records in New England have covered a period of forty to fifty years or more, and a study of those long records indicates that even up to the present time they still don't show a true average. For example, one of our longest records indicates a steady decrease in the amount of flow from the beginning to the end of that period. This is explained, I believe, by the accompanying gradual and equally steady decrease in rainfall. During this period there have been three distinct cycles of run-off from fifteen to twenty years in length, each one starting and ending with a period of low run-off with intervening years of high run-off. The conclusions reached regarding decreasing flow which refer only to this particular stream were based on a comparison of the average rainfall and run-off in each of these three cycles, which eliminated their effect in studying the entire period. I believe that this decrease in rainfall and run-off may be taken as an indication of the existence in New England of a still longer climatic cycle, producing small but definite changes of consequence in the average rainfall and run-off over long periods of time, the proof of which can be established by continuous accurate measurements of both rainfall and run-off. To summarize, I believe that a river record to be of most value ought to cover a very long period of time, a point which Mr. Kinnison has already discussed, and also that in an interpretation of such a record sufficient rainfall stations should be established in the drainage basin so distributed

* Consulting Engineer, 6 Beacon Street, Boston, Mass.

as to furnish an equally reliable estimate of the rainfall in the area.

Another thing which has been very interesting to me is the peculiar diminution of the rate of flow noted in most of our rivers as the drainage area gets larger. On both the Merrimack and the Connecticut this is a marked characteristic of the flow. Near the head waters of both streams the run-off is well in excess of 2 second feet per square mile, and approaches and in cases exceeds 3 second feet per square mile on the smaller tributaries draining areas whose average altitudes equal or exceed 2,500 feet, whereas at the mouth of the rivers the run-off is much reduced, — in the case of the Merrimack, to less than one-half the maximum rate, or 1.5 second feet per square mile. This discrepancy, I believe, can be partially but not wholly accounted for by the decrease in precipitation with the general gradual decrease in altitude of the drainage basin.

If one considers the flow from the intervening drainage area between two gaging stations on such a stream or the increment of flow from the additional drainage area below the upper station, and deducts the recorded flow on any tributaries in this additional drainage area and on which gaging stations are maintained, it will sometimes be found that the rate of flow from this remaining additional drainage area will be smaller than any of our New England stream-flow records. For example, if one deducts the record of flow of the Merrimack at Franklin Junction from the record of flow of the Merrimack at Manchester, and also deducts the recorded flow of the tributaries in the intervening area between these stations, namely, that on the North Branch of the Contoocook near Antrim, on Nubanusit Brook near Peterboro, and on the Suncook River at North Chichester, one finds at low-water seasons of the year that the rate of flow from the remaining drainage area is very small.

I was very much interested in studying the reason for that, and it seemed to me after considering the various factors involved that water was being drawn from the river through subterranean channels, probably in a uniform manner along its course into the porous sands deposited in the wide valley of the main stream between Franklin Junction and Manchester, and also into similar deposits along the Contoocook and Suncook rivers, the water thus withdrawn, either being evaporated continuously from the ground surface of the lower areas of this sand plain or possibly serving as well to increase the ground-water storage in this area.

I thought that this would be of interest. It is simply an opinion of my own that after the effect of the smaller amount of rainfall has been taken into consideration the gradual, unexplained decrease in rate of flow of water in our larger rivers, with increase in drainage area, may be accounted for under similar circumstances in this way, and while several facts have been brought out which indicate that this is a correct solution, there are others which do not and there are others undetermined.

In closing I should mention that Mr. Kent and Mr. Crosby as well as myself were interested in this matter and have co-operated in furnishing and analyzing data in an investigation which is unfinished, and that this conclusion is one in which they may not agree.

TRUMAN H. SAFFORD* (by letter): Mr. Kinnison has given us a very clear picture of the collection and use of stream-flow data. In the course of his paper he has described in detail the method most commonly used by the United States Geological Survey in obtaining the record of flow of a stream — by rating a natural control. I would like to discuss briefly another method of obtaining stream-flow records applicable in a more limited field.

Frequently it is desirable to obtain stream-flow records on a stream where all the available fall has been developed, so that the river is virtually a succession of pools with no quick water between, affording an opportunity for rating a natural control. In such a case it may be possible to obtain stream-flow records by using the records of operation of water-power plants and obtaining the flow as the sum of that used through the water wheels and wasted over the dam. This method is open to the objection of being laborious, both in the work of rating the station and working up the results.

To rate such a station properly there must be a good measuring section in the waterways, affording an opportunity both to measure the discharge of the wheels of the water-power plant under all operating conditions, and to measure the flow over the dam. On dams which carry flashboards, and this of course is true of most of them, frequent measurements are necessary to define the stage discharge relation when the boards are in bad shape. Furthermore, there is the practical difficulty of having a large number of individual observations taken by plant operators honestly and intelligently made.

In many cases when a station of this type is established, it is possible to work up several years of back records, making the record available

* Assistant Engineer, Metropolitan District Water Supply Commission, 24 School Street, Boston Mass.

over a longer period of time than would be otherwise possible. There is also apt to be less difficulty in working up the winter record due to ice trouble than with a natural control.

There are several examples in New England of this type of station, the most famous being perhaps the record of the Merrimack River at Lawrence, maintained by the Essex Company and published by the United States Geological Survey. Another record of the same general type is that of the Kennebec River at Waterville, Maine, maintained by the Hollingsworth & Whitney Company and published by the United States Geological Survey.

The Metropolitan District Water Supply Commission, in co-operation with the United States Geological Survey and the United Electric Light Company of Springfield, have established a station on the Chicopee River at the power company's Bircham Bend plant. The record is worked up from automatic recorder charts which give the head and tail water level and the wheel governor openings. A station has been established on the Swift River by the Metropolitan District Water Supply Commission in co-operation with the Otis Company at their Boston Duck Mills plant at Bondsville (Palmer), Mass. At this station very close agreement has been obtained with the West Ware station of the United States Geological Survey, about five miles above.

OF GENERAL INTEREST

AWARDED TO THE LOWEST BIDDER

By Edward Grossman

Once upon a time, as the fairy tale hath it, the construction business was mere guesswork; now, in our civilized and systematized present, construction bidding is almost a science, comparing favorably with arithmetic, which, as we all know, is an exact science, as will be seen from the following example. In a certain college not far from here a class in thermodynamics was given a problem to do. All the data were given, each item being labeled. All the students had to do was to substitute the given value of each item for the item in the formula, move the slide on the slide rule, and get the answer. There was a variation of 40 per cent between the lowest and the highest. Construction bidding, if public work is any criterion, is as exact a science as the aforementioned students' arithmetic.

Conditions are such that a great many constructors do not care to bid on public work for fear of "crazy bids." This year it is likely that there will be a preponderance of public work, so that unless some brake is applied to cut-throat bidding, many constructors will continue without work, finally causing a mad scramble, with subsequent worse demoralization than exists at present.

Theoretically, every constructor has an equal chance to bid on public work; practically he has not. In practice a premium is put on irresponsible bidding, because no safeguards are applied in the selection of bidders. On a recent army job — a housing development — 85 sets

of plans were distributed to all who had \$25 to deposit for them. Of the 85, there were about 47 constructors. Seventeen bids actually were turned in. There was a difference, between the low and the high bids, of approximately \$285,000 on a job having an "average bid" of \$517,300.

"Crazy" bids do not make for profitable jobs, and usually an unreasonably low price may be considered a sign of incompetence or carelessness. Mistakes are, of course, made by all at times, — no one is perfect, — but apparently, in bidding for construction work, many bidders are making mistakes all the time, either accidentally or intentionally, and this does not make for a healthy condition in the construction industry.

Several examples of recent bidding on public work follow. These will no doubt be instructive, possibly entertaining, and, perhaps, give an answer to the question why an estimator acts wild nowadays. These examples comprise bids on federal, state and city work.

1. *Senior High School* (14 bids). A, \$221,500; B, \$225,000; C, \$238,000. Second highest, \$271,177; highest, \$306,500; average, \$250,336.

2. *Bathhouse*. — This project is interesting because it was figured twice, plans and specifications not being changed in any very important particular.

(a) First bidding (9 bidders): A,

\$46,770; B, \$55,900; C, \$60,500; D, \$60,550; E, \$61,350; F, \$63,099; G, \$63,850; H, \$67,969; I, \$69,400. Average, \$61,043.

(b) Second bidding (9 bidders, not all the same): J, \$53,100; K, \$53,300, (awarded contract); A, \$55,307; D, \$55,750; G, \$58,150; C, \$58,300; L, \$58,500; M, \$59,690; E, \$59,700. Average, \$55,755.

3. *Sewer*. — A, \$219,650; B, \$235,627; C, \$259,193. Average, \$238,157. Engineer's estimate, \$244,671.

4. *Street*. — A, \$88,327; B, \$91,843; C, \$93,788. Average, \$91,319.

This, for a change, is a good line of figures. The interesting part is that the engineer's estimate for this work was \$119,740.

5. *High School* (8 bidders). — A, \$893,000; B, \$898,000; C, \$916,400. High, \$1,060,000; average, \$944,725. Nearest bid to average, \$945,000.

6. *Bathhouse* (17 bidders). — A, \$107,554; B, \$116,385; C, \$118,000. High, \$168,000; average, \$134,063. Nearest bid to average, \$133,500.

7. *Jail* (17 bidders). — A, \$79,960; B, \$84,487; C, \$89,421. High, \$113,000; average, \$98,664. Nearest bid to average, \$98,617.

8. *Armory* (20 bidders). — A, \$57,557; B, \$59,500; C, \$59,720. High, \$78,900; average, \$67,280. Nearest bid to average, \$67,246.

In connection with the tabulations it should be noticed that in cases where the average bid runs noticeably higher than the three lowest given, the latter are excessively low, the majority of the bids running higher than the lows. Thus, for example, on the armory (Project 8) the three low figures were all alone in their glory, the other figures being noticeably bunched at between sixty-five and seventy thousand dollars.

Such lists of bids could be prolonged indefinitely, as we all know. What is the reason for such bidding? It must be

admitted that some plans and specifications leave much to be desired. There are plans, indeed, so poor that it is doubtful whether their originators themselves would be able to take off quantities from them if they saw those plans for the first time. Most plans are, however, reasonably clear. The plans on Projects 2, 7, and 8 were remarkably so, the only possible uncertainties being about \$500 worth on Project 9, and not over \$300 on Project 13. Yet note the range in prices.

Where the plans and specifications are reasonably clear the only explanation possible for variations in bids is that people who do not figure properly are allowed to bid on work in the hope that a bargain may be had. There are very few bargains in this world. Allowing people who do not figure profit, or are careless, to bid on work, only militates against properly qualified constructors who are in the business to make a living and not for their health.

Some engineers and architects consider it feathers in their respective hats when constructors are awarded their work at prices way below what they hoped the cost would be. It is no mark of distinction at all. It is rather an indication that something is wrong somewhere, just as something is wrong when bids vary greatly on a job having reasonably clear plans and specifications.

A remedy must be applied, and applied soon, or complete demoralization will set in. At present we are only on the way to it.

The first thing to do is to make sure that plans and specifications are clear, so that one does not have to learn legal phraseology or "pidgin English," or both, in order to understand them.

Once having made sure of the plans and specifications, the bidders must be weeded out. One way is by means of the certified check, which is usually re-

quired with the bid on public work. A sort of test should also be applied.

With regard to the check the suggestion is that the certified check should be insisted on. It is customary to accept, also, bank treasurers' checks, just so long as the city or state is protected. But the constructor should also be protected. The bank check is a sort of accommodation loan, but the certified check is an immediate and direct drain on the financial resources of the bidder, for the amount of the certified check is at once deducted from his bank balance. There is no reason why some bidders on a public job should be so penalized while others "get away with it."

A bidder desiring a set of plans should also be asked to show how he has been bidding on a few previous jobs, so that it may be known whether or not he is erratic. If five or six consecutive bids show him too high on one, or too low on the other, or give other signs of fluctuation, he should not be allowed to figure; also, his methods of doing business should be scrutinized.

Objection to these tests might be raised on the ground of discrimination, but such objections will be out of order, for it will merely militate against the irresponsible or careless bidders. The others will be sure of a chance of bidding on a job so that there will be a profit in it. Construction is not a fly-by-night affair. A constructor is entitled to put a profit on his work as well as a grocer or a dry goods merchant.

Under present conditions it is not possible for the constructor to figure much, if any, profit. He must get along as best he can, considering himself lucky if he obtains his week's salary out of a job. This is not a healthy state of affairs. In order to remedy the situation the engineer and the architect must help. It will be for the benefit of all.

This matter of helping distinctly does not mean, however, that discrimination should be allowed to enthrone itself. A prospective bidder should not be rejected because the engineer or the architect does not like his looks or his name. That is gross unfairness, and the constructor would be amply justified in bringing the offending engineer or architect into court for interfering with his rights. If, on the other hand, his record is clear, and he can show the designer of the building or other structure that he is a fit person to bid on the work, there is no reason why he should not be allowed to do so.

It will be well, therefore, to remember that the constructor has rights which the designer must respect, but at the same time it is the latter's duty to make sure that proper persons bid on the work. It is admittedly a delicate matter, requiring absolute fairness and a great deal of common sense on the part of the engineer or architect. Can he rise to the situation without becoming a bigot?

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

APRIL 16, 1930. — A regular meeting of the Boston Society of Civil Engineers was held today in Chipman Hall, Tremont Temple, and was called to order by the President, Lewis E. Moore, at 7.15 P.M.

There were 75 members and guests present.

The reading of the minutes of the Annual Meeting, held on March 19, 1930, was omitted, as these are printed in the April JOURNAL.

The Secretary announced that the following had been elected to membership by the Board of Government:

Grade of Member: James H. Brady, James J. Healy, Theodore W. Kappler.

Grade of Junior: Martin J. Markham.

The Secretary announced the result of the letter ballot on the matter of the endorsement by the Society of the practice of using an Arbitration clause in construction contracts, as follows: Yes, 229; No, 5. (This matter was voted upon at the meeting on February 19, 1930.)

The President announced the death of Lawrence E. Kilpatrick on March 19, 1930.

The President introduced as the speaker of the evening Mr. H. B. Kinnison, District Engineer, Water Resources Branch, United States Geological Survey, who presented a paper on "Stream-Flow Data, — Its Collection and Use", which was illustrated with lantern slides. The methods, equipment, records and numerous graphs of stream-flow data, with explanations of the principles of their use and interpretation, were presented.

Following the address there was discussion by Prof. H. K. Barrows, Howard M. Turner and Edward A. Graustein.

The meeting adjourned at 9.30 P.M.

EVERETT N. HUTCHINS, *Secretary*.

Designers' Section

APRIL 9, 1930. — A regular meeting of the Designers' Section was called to order at 6.10 P.M. by Norman P. Randlett, Chairman, in the Affiliation Rooms.

The reading of the minutes of the March meeting was omitted.

The Chairman introduced Prof. T. H. Frost of the Massachusetts Institute of Technology, who spoke on "The Separate Effects of Shears and Moments on Rigid Frame Bents." The remarks were illustrated by lantern slides, showing the results of photo-elastic studies of rigid frames.

At the conclusion of the talk Professor Frost answered the questions of many of the members.

There were 23 members and guests present. The meeting adjourned at 7.15 P.M.

LAWRENCE G. ROPES, *Clerk*.

Sanitary Section

MAY 7, 1930. — Preceding the meeting, twenty members attended dinner at Paten's Restaurant.

At 7.15 the meeting was called to order by the Vice-Chairman, in the Chairman's absence. Twenty-six members were present.

The subject of the evening, a symposium on the subject, "Actually, Now, Are Pigs Pigs?", was discussed by the following:

1. Edward Wright, assistant engineer of the Massachusetts Department of Public Health, who outlined the policies and experiences of his department in connection with piggeries.

2. George C. Houser, assistant engineer with Metcalf & Eddy, who read a paper describing good engineering practice in

piggery construction, illustrated by motion pictures.

3. Frank L. Flood, assistant engineer with Metcalf & Eddy, who also read a paper on the engineering of piggery construction, illustrated by lantern slides.

4. Prof. Gordon M. Fair of Harvard University, who read two official letters describing the results of official investigation of a piggery at an army post.

5. Vice-Chairman Francis H. Kingsbury, assistant engineer of the Massachusetts Department of Public Health, who spoke of his experiences along this line, illustrated by lantern slides.

6. Mr. Potter, proprietor of the Breezy Hill Piggery in Lexington, recommended by Dana M. Wood to give the experiences of an operator of a properly run piggery, who contributed a valuable fund of practical information on the habits of pigs and their maintenance.

7. Mr. Edgar S. Dorr, who spoke on various phases of the subject, particularly the collection of garbage.

Contributions to the discussion were also made by Messrs. Doane and Crocker, the latter telling of the city of Brockton's piggery problems.

The meeting adjourned at 9.30.

GEORGE G. BOGREN, *Clerk*.

APPLICATIONS FOR MEMBERSHIP

[May 20, 1930]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of fifteen (15) days from the date given.

For Admission

HOWARD, JOHN W., Everett, Mass. (Age 25, b. Cambridge, Mass.) Graduate of Everett High School and Northeastern Polytechnic School. From July, 1927, to 1930 have been in the employ of J. R. Worcester & Co. as structural engineer; from January, 1930, to date, with John R. Nichols, in the same capacity. Refers to *G. E. Meyers, J. R. Nichols, N. P. Randlett, Thomas Worcester*.

MACCARIO, CHARLES V., Malden, Mass. (Age 21, b. East Boston, Mass.) Graduate of Malden High School. Is now a junior at Northeastern University. During co-operative periods have been employed by H. Richardson, South Harwich, as transitman and rodman; by the city of Melrose, and by W. W. Churchill of Milton, Mass., in the same capacity. Refers to *H. B. Alvord, C. O. Baird, G. B. Gee, J. W. Ingalls, W. E. Nightingale*.

For Transfer to Grade of Member

GINSBURG, NATHAN, East Boston, Mass. (Age 26, b. East Boston, Mass.) Graduate of Massachusetts Institute of Technology in 1924. Experience since then: July, 1924, to May, 1925, with the Boston Elevated, computing stresses in bridges; May, 1925, to December, same year, with Massachusetts State Highway as transitman; December, 1925, to April, 1926, with highway engineer, Norfolk County, as transitman; from April, 1926, to April, 1928, with Stone & Webster Engineering Corporation, detailing and designing concrete structures; April, 1928, to date, with New England Power Construction Company, detailing and designing light steel structures. At present unemployed. Refers to *J. B. Babcock, H. K. Barrows, F. C. Bell, H. C. Hartwell, H. L. White*.

MEYER, GEORGE E., Norwood, Mass. (Age 26, b. Norwood, Mass.) Graduate of

Northeastern University in 1927, with Bachelor's degree in civil engineering. During co-operative periods at the University was employed by Whitman & Howard, town of Milton and city of Newton. June, 1927, to September, same year, was engineer with Gleason Engineering Corporation, Wellesley, Mass.; September, 1927, to January, 1930, was structural engineer with Concrete Steel Company, Boston; at present with J. R. Nichols, Boston, as structural engineer. Refers to *H. B. Alvord, W. H. Gleason, A. L. Maddox, J. R. Nichols, N. P. Randlett.*

WATSON, GEORGE N., Milton, Mass. (Age 28, b. Manchester, Mass.) Graduate of Northeastern University. From 1918 to 1926 was employed in the Engineering Department of the town of Watertown as rodman, and later as assistant engineer; in the fall of 1926 became town engineer of Milton, Mass., which position am now holding, but have just been appointed town engineer, Braintree, Mass. Refers to *O. D. Allen, J. H. Bowie, F. J. Maynard, E. C. Sargent, W. M. Smith.*

NEW MEMBERS

Members

- CONSTANTINO ANTONELLI, 77 Rodman Street, Quincy, Mass.
 JAMES H. BRADY, 31 Bertram Street, Dorchester, Mass.
 JAMES J. HEALY, 5 Prescott Street, Charlestown, Mass.
 THEODORE W. KAPPLER, 190 Beach Street, Wollaston, Mass.
 HAROLD A. PALMER, 26 Lexington Terrace, Waltham, Mass.

Juniors

- JOHN J. CAMPOBASSO, 44 Decatur Street, Arlington, Mass.
 MARTIN J. MARKHAM, 35 Lincoln Street, Stoneham, Mass.
 RICHARD D. MURPHY, 27 Union Street, Lynn, Mass.
 EDWIN J. O'CONNOR, 52 Pickering Street, Danvers, Mass.

DEATHS

- CLAYTON C. ALEXANDER . April 1, 1930
 JOHN V. CORBETT . May 14, 1930
 WILLIAM L. VENNARD . April 29, 1930

BOOK REVIEWS

*"Le Port de New York dans son Rôle Économique,"** by Gaston Eyskens, Louvain, Bibliothèque de l'Ecole des Sciences Commerciales de l'Université de Louvain, René Fonteyn, Editeur, 1929.†

Monsieur Eyskens has pictured the world's first port from the viewpoint of a European economist. It is an excellently documented and thorough study of the commerce, traffic, rates and operation of the port based on statistics up to and including those for 1928, and on an intimate, personal study on the ground.

The first part describes the nature of the commerce, analyzing the ocean, canal, coastal, intercoastal, and passenger traffic; the commercial products handled and their origins; and the economic function of the port in the relation to the movement of these products. The very favorable load factor for both foreign and coastwise commerce is clearly portrayed. The author well points out that for any other country the coastwise domestic commerce would be international.

The second part deals with the causes of the greatness of the port; its heritage from the past; the opening up and growth of the virgin country and its natural outlets; the means of communication with the interior and with the ports of the world; the piers, terminals, warehouses, and their equipment; and the organization, operation, and administration of the port. The picture of the development of the port is very happily drawn, showing the various factors effecting it and the particularly rapid progress after the success of the "Clermont" and the introduction of steam to navigation. Much space is given to the settlement and growth of the hinterland, with its three natural

* The Port of New York and its Economic Function.

† Reviewed by J. Stuart Crandall, Crandall Engineering Company, 134 Main Street, Cambridge, Mass.

outlets,— the Mississippi River, Great Lakes; St. Lawrence River, and the Mohawk; Hudson River,— and the result of the construction of the Erie Canal. The interior means of transportation by rail, canal, highway, and air are described in detail, and the maritime transportation with world ports is carefully analyzed. There is an excellent description of the organization of the port, its facilities, movement of freight, including the commercial and administrative formalities of export and import operations.

The third part analyzes the principal problems of the port, such as railroad net and connections, freight terminals, belt lines, and car floating; rational operation of the piers and equipment, and terminal charges. A chapter is well devoted to the rate structure, causes, trends, tariff wars, and competition between ports. Here Monsieur Eyskens points out the artificiality of the port differentials, which he apparently considers inequitable, but he might have shown that the absorbed free lighterage cost is a tribute the rest of the country pays to benefit New York's export traffic. The final chapter foretells the probable future of the port of New York as affected by the Mississippi River, Hudson Bay, and St. Lawrence Canal routes. In conclusion, he believes that the experience of New York clearly shows that of necessity any port must establish definite plans for development years in advance; that the destiny of ports is best controlled by a public body where economists and engineers have a preponderant influence; and that in the Port Authority, New York will find new and fertile initiative for logical development.

Monsieur Eyskens deserves commendation for this timely study, well done. The bibliography is excellent, most complete, and of great value in itself. This book should be in the library of every port engineer and economist. It is to be hoped that an English translation may soon render the information more generally available.

*"Flood Flows— A Study of Frequencies and Magnitudes," by Allen Hazen. John Wiley & Sons, Inc., New York, 1930.**

The fundamental basis for the consideration of flood flow is the "average yearly flood," as first defined by Weston E. Fuller.† The author suggests calling this the mean flood, but the term as used by Fuller appears more specific. This factor — easily determined by a stream-flow record of reasonable length — gives an accurate measure of the flood characteristics of a stream. Streams may be compared by means of the coefficient C in the formula $Q_{av} = C A^{0.8}$ for average yearly flood.

Instead of introducing a time factor like Fuller to study variation in flood flow, the author prefers to do this graphically — plotting per cent of time against ratio to the average yearly flood — favoring for this purpose logarithmic probability scales. He considers that these curves will be skew curves, and considerable attention is given to the details of methods for determining skew curves that will fit such data.

The writer does not agree with the author that there is "no such thing as a maximum flood." In other words, that it will only be a question of time before a flood greater than ever before will occur. The writer agrees with Horton,‡ who reasons with reference to rainfall that there is some, although perhaps unknown, limit in amount. Similarly with floods, there is some limit in rainfall, with a combination of other circumstances, occurring rarely (and perhaps not yet a matter of record in many localities) which will give a maximum flood. It is likely that in

* Reviewed by H. K. Barrows, Professor of Hydraulic Engineering, Massachusetts Institute of Technology, and Consulting Engineer, Boston.

† Transactions of American Society of Civil Engineers, Vol. 77, 1914, p. 564.

‡ Journal of New England Water Works Association, March, 1927, p. 23.

some parts of Vermont this condition developed in November, 1927, where thirty-six-hour rainfalls of 9 inches and over occurred.

An extensive table of flood records is given, including coefficients of average yearly flood and the ratio of the 1 per cent chance-flood (or 100-year flood) to the average yearly flood. The writer notes two rivers in this list, however, viz., the Kennebec and Androscoggin, upon which extensive storage control exists, where the entire drainage area is used instead of that uncontrolled — thus giving misleading results.

More space could well have been given to the relation between maximum daily floods and peak or crest flows — a

very important factor with moderate sized streams. In this connection some treatment of the form of flood hydrographs would be of value.

No attention is given to the many striking data of flood flow in New England in November, 1927, which would have been of interest and value at this time.

Interesting chapters are included upon "Forests," "Channel Control," "Storage," etc., with a discussion of their relations to flood flow and control. Economic limits of flood protection are also discussed.

This book will be found of interest and value to engineers and students in this phase of hydraulic engineering.

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

INDEX TO ADVERTISERS

	PAGE
ASPINWALL & LINCOLN, 46 Cornhill, Boston	iii
ASSOCIATED ARCHITECTS PRINTING & SUPPLY CO., 25 Pearl St., Boston	x
BARBOUR, FRANK A., Tremont Building, Boston	iv
BARROWS, H. K., 6 Beacon St., Boston	iii
BAY STATE DREDGING AND CONTRACTING CO., 62 Condor St., East Boston	x
BEATTIE, ROY H., 209 Bedford St., Fall River	ix
BERRY DRAFTING SERVICE, 101 Tremont St., Boston	iv
BISHOP, J. W., Co., 100 Erie St., Cambridge	viii
BLAIR, ISAAC, & CO., INC., 433 Harrison Ave., Boston	xii
BOSTON INSULATED WIRE & CABLE CO., Dorchester	vi
BRUNO & PETITTI, CONTRACTORS, 18 Tremont St., Boston	v
BUFF & BUFF CO., Jamaica Plain	ix
COLEMAN BROS., 245 State St., Boston	ix
CRANDALL ENGINEERING CO., 134 Main St., Cambridge	xi
CROSBY, IRVING B., 6 Beacon St., Boston	iii
EASTERN BRIDGE AND STRUCTURAL CO., Worcester	viii
FAY, SPOFFORD & THORNDIKE, 44 School St., Boston	iii
FULLER & MCCLINTOCK, 170 Broadway, New York	iii
GIBSON & WILLIAMS, INC., 65 Long Wharf, Boston	ix
GOSS, JOHN L., CORPORATION, 77 Summer St., Boston	xiv
GOW COMPANY INC., 956 Park Square Building, Boston	vi
GRANITE PAVING BLOCK MFRS.' ASSOC., 31 State St., Boston	xiii
GRAUSTEIN, EDWARD A., 6 Beacon St., Boston	iv
HOLZER, U., INC., 333 Washington St., Boston	vii
JACKSON & MORELAND, Park Square Building, Boston	iii
MAIN, INC., CHAS. T., 201 Devonshire St., Boston	ii
MAKEPEACE, INC., B. L., 387 Washington St., Boston	Back cover
METCALF & EDDY, Statler Building, Boston	iii
MONAHAN PUMP EQUIPMENT CO., 10 High St., Boston	ix
MONKS & JOHNSON, 99 Chauncy St., Boston	iv
NEW ENGLAND CONCRETE PIPE CORP., 79 Milk St., Boston	v
NEW ENGLAND FOUNDATION CO., INC., 38 Chauncy St., Boston	ix
NEW ENGLAND POWER ASSOCIATION, 89 Milk St., Boston	viii
NEW ENGLAND WOOD PRESERVING CO., Chamber of Commerce Bldg., Boston	xii
OLD CORNER BOOK STORE, 50 Bromfield St., Boston	ix
PACKARD, GEORGE A., 50 Congress St., Boston	iv
PITTSBURGH TESTING LABORATORY, 101 Tremont St., Boston	iv
RIDEOUT, CHANDLER & JOYCE, 130 Broad St., Boston	ix
SCULLY CO., 238 Main St., Cambridge	vii
SIMPSON BROS. CORPN., 77 Summer St., Boston	v

	PAGE
SMITH, B. F., & Co., Merchants Bank Building, 79 Milk St., Boston	ix
STANDARD OIL CO. OF NEW YORK, 31 St. James Ave., Boston	xii
STUART, T., & SON Co., 70 Phillips St., Watertown, Mass.	xi
SYMONDS & STEVENS, 70 State St., Boston	iv
THOMPSON & LIGHTNER, THE, Co., Inc., Statler Building, Boston	iii
THORPE, LEWIS D., 6 Beacon St., Boston	iii
TREDENNICK-BILLINGS Co., 10 High St., Boston	vii
TUCKER, EDWARD A., Co., 101 Milk St., Boston	iv
TURNER, HOWARD M., 12 Pearl St., Boston	iv
WARREN FOUNDRY AND PIPE Co., 201 Devonshire St., Boston	vii
WESTON & SAMPSON, 14 Beacon St., Boston	iii
WHIDDEN-BEEKMAN ENGINEERING Co., 100 Arlington St., Boston	iv
WHITMAN & HOWARD, 89 Broad St., Boston	iii
WOLF, EZEKIEL, 160 State St., Boston	iv
WORCESTER, J. R., & Co., 79 Milk St., Boston	iii
WRIGHT & POTTER PRINTING Co., 32 Derne St., Boston	x

**A BUSINESS CARD in this Journal shows
your interest in the Society and your
appreciation of the patronage of its members**

PROFESSIONAL CARDS

CHAS. T. MAIN, INC.

ENGINEERS

201 DEVONSHIRE STREET, BOSTON, MASS.

DESIGN AND SUPERVISION OF CONSTRUCTION
INDUSTRIAL BUILDINGS
ELECTRICAL, STEAM AND HYDRAULIC ENGINEERING
VALUATIONS AND REPORTS
CONSULTING ENGINEERING

CHARLES T. MAIN
F. M. GUNBY
HARRY E. SAWTELL
W. F. UHL

CHARLES R. MAIN
A. W. BENOIT
MARCUS K. BRYAN
R. A. MONCRIEFF

IRVING B. CROSBY**Consulting Geologist**

Investigations of Dam and Reservoir Sites
Water Supplies and Foundations
Quarries, Sand and Gravel Deposits

Application of Electrical Prospecting Methods to
Foundation Problems

6 BEACON ST. BOSTON, MASS.

ASPINWALL & LINCOLN**Civil Engineers**

46 CORNHILL

BOSTON

FAY, SPOFFORD & THORNDIKE**Consulting Engineers**

Investigations	Reports	Designs
Engineering Supervision		Valuations
Port Developments		Industrial Plants
Bridges	Buildings	Foundations
Water and Sewerage Systems		

44 SCHOOL STREET, BOSTON

FULLER & McCLINTOCK**Engineers**

NEW YORK, 170 Broadway

PHILADELPHIA, PA.	KANSAS CITY, MO.
Pennsylvania Bldg.	Walsix Bldg.
15th and Chestnut Sts.	600 Walnut St.

H. K. BARROWS**Consulting Hydraulic Engineer**

Water Power, Water Supply, Sewerage,
Drainage. Investigations, Reports, Valua-
tions, Designs, Supervision of Construction

6 BEACON ST. BOSTON, MASS.

METCALF & EDDY**Engineers**

Harrison P. Eddy	John P. Wentworth
Charles W. Sherman	Harrison P. Eddy, Jr.
Almon L. Fales	Arthur L. Shaw
Frank A. Marston	E. Sherman Chase

Water, Sewage, Drainage, Refuse and
Industrial Wastes Problems

Valuations Laboratory
STATLER BUILDING BOSTON, MASS.

SANFORD E. THOMPSON, Pres. WILLIAM O. LICHTNER, Treas

THE THOMPSON & LICHTNER CO., INC.**Engineers**

Management and Production
Investigations
Design and Engineering Supervision
Testing of Structural Materials

Offices and Laboratory, STATLER BUILDING, BOSTON

LEWIS D. THORPE**Civil and Sanitary Engineer**

Water Works, Sewerage and Sewage
Disposal

Supervision of Construction and Operation

6 Beacon Street

BOSTON, MASS.

WESTON & SAMPSON

ROBERT SPURR WESTON G. A. SAMPSON

Laboratory for the Analysis of Water,
Sewage, Filtering Materials, etc., Design,
Inspection and Supervision of Water Puri-
fication and Sewage Disposal Plants.

14 BEACON STREET, BOSTON, MASS.

WHITMAN & HOWARD**Civil Engineers**

(Established in 1869)

89 Broad Street Room 526

BOSTON

J. R. WORCESTER & CO.**Engineers**

BUILDINGS BRIDGES FOUNDATIONS
STEEL AND REINFORCED CONCRETE
DESIGNS INVESTIGATIONS
EXPERT TESTIMONY
CEMENT AND SAND TESTING

79 MILK STREET BOSTON, MASS.

Dugald C. Jackson Edward L. Moreland

JACKSON & MORELAND**Consulting Engineers**

PARK SQUARE BUILDING

BOSTON, MASS.

PITTSBURGH TESTING LABORATORY
Inspecting Engineers and Chemists

D. L. MACDONALD
 New England Representative

101 TREMONT STREET, BOSTON

FRANK A. BARBOUR
Consulting Engineer

Water Supply, Water Purification
 Sewerage and Sewage Disposal

Tremont Building, Boston, Mass.

HOWARD M. TURNER
Consulting Engineer

Investigations, Valuations, Plans,
 Supervision of Construction, Water
 Power, Water Supply, Public Utility
 and Industrial Properties

12 Pearl Street : : : Boston

SYMONDS & STEVENS
Consulting Engineers

70 State St. Boston, Mass.
 WATER SUPPLY AND DRAINAGE
 Surveys — Estimates — Designs
 Supervision
 MANAGEMENT AND ORGANIZATION
 EFFICIENCY REPORTS

Whidden-Beekman
Engineering Company

100 Arlington St., Boston

STRUCTURAL ENGINEERS
 RIVETED OR WELDED DESIGN

MONKS & JOHNSON

ARCHITECTS—ENGINEERS

99 Chauncy Street
 Boston

EDWARD A. TUCKER COMPANY
Contracting Engineers

CONCRETE REINFORCEMENT
 REMOVABLE METAL FORMS
 101 Milk Street, Boston, Mass.

EDWARD A. GRAUSTEIN
Consulting Engineer

WATER POWER
 HYDRAULIC—STRUCTURAL—CIVIL
 SOILS TESTING LABORATORY
 Investigations—Valuations—Court Work
 Design and Supervision

6 BEACON STREET - - BOSTON

GEORGE A. PACKARD
MINING . .
ENGINEER

50 CONGRESS STREET
 BOSTON

EZEKIEL WOLF

Reg. Patent Attorney and Engineer
 Counsellor at Law
 Patent and Trade-Mark Causes
Consultation by Appointment
 160 STATE ST., BOSTON, MASS.
 Telephone Richmond 3620

SIMPSON BROS. CORPORATION



ENGINEERS AND CONTRACTORS

FOR

REINFORCED CONCRETE
CONSTRUCTION

HASSAM CONCRETE STREET PAVEMENT

JOSEPH BRUNO

FRANK PETITTI

ALPHONSO BRUNO

BRUNO & PETITTI CONTRACTORS

WATERWORKS, SEWERS, HIGHWAYS AND
CONCRETE CONSTRUCTION

18 Tremont Street,

Boston, Mass.

SPECIFY THE STRONGER, MORE DURABLE PIPE
FOR SEWERS, DRAINS AND CULVERTS

Use

Machine Made Plain
and

Reinforced Concrete Pipe

NEW ENGLAND CONCRETE PIPE CORPORATION

79 Milk Street

Boston, Massachusetts

Plant

NEWTON, MASS.

HUBbard 9348

Boston Insulated Wire & Cable Co



SPECIFY **B.I.W.** WIRES






MAIN OFFICE & FACTORY
DORCHESTER DISTRICT
BOSTON 25, MASS

CANADIAN FACTORY
BOSTON INSULATED WIRE
& CABLE CO., LTD.
HAMILTON, ONTARIO

FOUNDATIONS
ENGINEERS AND CONTRACTORS

The Gow Company Inc.
956 Park Sq. Building
Boston

GOW CAISSONS
RAYMOND CONCRETE PILES
SOIL TEST BORINGS

90 WEST ST., NEW YORK CITY 111 W. MONROE ST., CHICAGO

THE SCULLY COMPANY

Building Construction

238 MAIN STREET

CAMBRIDGE, MASS.

WARREN FOUNDRY and PIPE CO.

(FORMERLY WARREN FOUNDRY AND MACHINE COMPANY)

MANUFACTURERS OF

Cast Iron Gas and Water Pipe

FLANGE PIPE

SPECIAL CASTINGS

201 Devonshire St.,
BOSTON, MASS.

} **SALES** }
} **OFFICES** }

11 Broadway,
NEW YORK

THE TREDENNICK-BILLINGS CO.

Building Construction

10 HIGH ST.

Telephone LIBerty 2480

BOSTON

U. HOLZER, Inc.

BOOK - BINDER

333 WASHINGTON ST., OPPOSITE MILK ST., OR 24 PROVINCE ST.

ESTABLISHED 1870

All kinds of Books bound and repaired.

Maps and Charts mounted.

Portfolios, Scrap Books, Blank Books, etc., made to order.

Lettering in Gold; Paper-Splitting; Inlaying; etc.

Photographs Mounted on Card or Paper without Cockling.

**Main Shop
at**

Hyde Park

Please mention the Journal when writing to Advertisers

EASTERN BRIDGE



— AND —



STRUCTURAL CO.

Worcester, Massachusetts,

For Prices on all Classes of

STEEL AND IRON WORK.

WE DESIGN AND MANUFACTURE

ROOF TRUSSES, GIRDERS, COLUMNS, STAIRS
AND FIRE ESCAPES FOR BUILDINGS

FOOT BRIDGES, HIGHWAY BRIDGES, RAILROAD BRIDGES

We Carry a Large Stock of
I-BEAMS, PLATES AND ANGLES

Can Make Quick Deliveries.   Send in Your Inquiries.

Compliments

of

New England Power Association

NEW YORK
101 PARK AVENUE .

CAMBRIDGE
100 ERIE STREET

J. W. BISHOP COMPANY
GENERAL CONTRACTORS

PROVIDENCE
TURKS HEAD BUILDING

WORCESTER
109 FOSTER STREET

Please mention the Journal when writing to Advertisers



Transits and Levels
WORLD FAMOUS
FOR 71 YEARS

BUFF PRECISION is continuously in the forefront



All Makes Repaired
 at Reasonable Cost

Buff & Buff Co.
 Jamaica Plain,
 Mass.

MONAHAN PUMP EQUIPMENT COMPANY
Complete Pumping Plants

FOR
 MUNICIPALITIES — PUBLIC BUILDINGS
 INDUSTRIES

Water Supply, Sewage, Boiler Feed, Fire
 Condensate, Vacuum, Circulating, etc.
 10 HIGH STREET, BOSTON, MASS.
 Telephone LIBerty 0788

RIDEOUT, CHANDLER & JOYCE

Engineers and Piping Contractors
 130 BROAD STREET — BOSTON, MASS.

Steam Specialties, Engineers' Supplies
 Piping of All Kinds Furnished or Erected

ROY H. BEATTIE

Harbor Improvements
Divers :: Lighters

209 BEDFORD STREET
 FALL RIVER, MASS.

SCIENTIFIC BOOKS
AND PERIODICALS

THE OLD CORNER BOOK STORE
50 Bromfield Street
BOSTON, MASS.

JAMES R. GIBSON

ALEX. K. WILLIAMS

GIBSON & WILLIAMS, INC.
BUILDING CONTRACTORS

MEMBERS
 MASTER BUILDERS' ASSOCIATION,
 BOSTON, MASS.

OFFICE: 65 LONG WHARF, BOSTON

B. F. SMITH & CO., INC.

ESTABLISHED 1878

Engineers and Contractors
ARTESIAN AND DRIVEN WELLS
FOUNDATION BORINGS

79 MILK STREET
BOSTON, MASS.

New England Foundation Co., Inc.

Engineering and Construction

Simplex Concrete Piles

Caissons — Difficult Foundations

38 CHAUNCY STREET BOSTON, MASS.

COLEMAN BROS., Inc.

JOHN F. COLEMAN, Pres. and Treas.

General Contractors and Builders

Main Office
 245 STATE STREET, BOSTON

Brewer Building HUBBARD 4880

Tracing Cloth Reproductions by Our Gelitho Process

We are its sole owners and producers.

BLUE, BLUELINE AND VANDYKE PRINTS
PHOTOSTAT PRINTS AND SUPPLIES

Associated Architects Printing and Supply Co.

25 PEARL STREET

BOSTON, MASS.

YOUR good is our good. We are here to serve **YOU**
Telephones LIBerty 1277 and 1278, connecting all departments



WRIGHT & POTTER PRINTING COMPANY

COMMERCIAL PRINTERS

32 Derne Street, - - Boston, Mass.

THIS entire building devoted to
all kinds of Book, Job and
Catalog Printing and Binding

Tel. Haymarket 2000 - 2001 - 2002

Bay State Dredging & Contracting Co.



CONTRACTORS

River and Harbor Improvements,
Sea Walls, Breakwaters, Heavy
Masonry Construction.

62 Condor Street, East Boston, Mass.

JAMES E. CASHMAN, Treas.

GORHAM H. WHITNEY, Prest.

DAVID J. WHITE, Gen. Mgr.

T. Stuart & Son Company

General Contractors



70 PHILLIPS STREET
WATERTOWN, MASSACHUSETTS

THE CRANDALL ENGINEERING COMPANY

CONSULTING AND
CONSTRUCTING ENGINEERS

DESIGN of Floating, Basin, and Railway Dry Docks,
Wharves, Piers, Bridges, etc

CONSTRUCTION of these and other Engineering
Structures

134 MAIN STREET
CAMBRIDGE, MASS.

STANDARD REFINED MEXICAN ASPHALTS

(SOCONY Brands)

Furnished of required penetration and specifications for construction of Asphalt Macadam and Asphalt Concrete Roads, and for Sheet Asphalt, Asphalt Joint Filler and Bridge Asphalt.

Standard Macadam Asphalt Binder for penetration applied by SOCONY Asphalt Sprayers under pressure, at suitable temperature

QUOTATIONS AND SPECIFICATIONS FURNISHED ON REQUEST

STANDARD OIL CO. OF NEW YORK

NEW ENGLAND DEPARTMENT

Park Sq. Building, 31 St. James Ave., Boston, Mass.

TIMBERS, LUMBER, PILING, POLES AND TIES

Preservatively Treated

With either Creosote or Zinc Meta-Arsenite

Timber treated with ZMA (Zinc Meta-Arsenite) is not stained or discolored and may be worked, finished and painted the same as untreated wood.

NEW ENGLAND WOOD PRESERVING COMPANY

Treating Plant

NASHUA, N. H.

Chamber of Commerce Bldg.

BOSTON, MASS.

GEO. A. BLAIR

L. L. STREET

W. O. WELLINGTON

ISAAC BLAIR & CO., Inc., General Contractors

Shoring and Moving Buildings a Specialty

433 Harrison Avenue, BOSTON

WHEN YOU DECIDE ON
GRANITE
FOR
CURBING OR PAVING
YOU SETTLE THE PROBLEM
FOREVER



**GRANITE PAVING BLOCK MANUFACTURERS'
ASSOCIATION OF THE U. S., INC,**

31 STATE STREET, BOSTON

GOSS PINK DEER ISLE GRANITE

The reliable material for bridge abutments, sea walls, curbing, and wherever severe conditions are encountered.

The beautiful material for buildings, memorials, and landscaping, where none but the best is wanted.

JOHN L. GOSS CORPORATION

77 SUMMER STREET

BOSTON, MASS.

COMMITTEES

NOMINATING COMMITTEE

Past Presidents (Members of the Committee)

EDWIN H. ROGERS

RICHARD K. HALE

FRANK E. WINSOR

C. FRANK ALLEN

WALDO F. PIKE

FRANK C. SHEPHERD

JOHN E. CARTY

JOHN L. HOWARD

C. HALE SUTHERLAND

(Term expires March, 1931)

(Term expires March, 1932)

SPECIAL COMMITTEES

Program

LEWIS E. MOORE, *Chairman, ex officio*

HAROLD K. BARROWS

HARVEY B. KINNISON

ATHOLE B. EDWARDS

EDWARD L. LOCKMAN

GARDNER S. GOULD

ARTHUR T. SAFFORD

EVERETT N. HUTCHINS

SAMUEL P. WALDRON

Publication

EVERETT N. HUTCHINS, *Chairman*

CHARLES W. BANKS

S. STANLEY KENT

J. STUART CRANDALL

WALDO F. PIKE

EDWARD GROSSMAN

JOHN P. WENTWORTH

Library

HENRY B. ALVORD, *Chairman and Librarian*

JOHN B. BABCOCK, 3d

SAMUEL T. DREW

BURTIS S. BROWN

WM. M. B. FREEMAN

WILLIAM A. BRYANT

EVERETT N. HUTCHINS

Legislative Matters

FRANK O. WHITNEY, *Chairman*

EDWIN H. WRIGHT

CHARLES R. MAIN

Subsoils of Boston

HARRY E. SAWTELL, *Chairman*

IRVING B. CROSBY

CHARLES D. KIRKPATRICK

HEYWOOD S. FRENCH

CHARLES W. ROBINSON

ALBERT C. TITCOMB

Social Activities

RICHARD W. SHERMAN, *Chairman*

CHARLES M. ANDERSON

KENNETH D. SYLVESTER

JOHN J. CAMPOBASSO

MERTON E. SYLVESTER

ARTHUR E. COLVIN

ROBERT H. VERNER

JOHN H. HARDING

PHILIP D. WHITE

Membership and Publicity

SAMSON K. COHEN, *Chairman*

CHARLES R. BERRY

DONALD L. MACDONALD

EDWIN A. DOW

FRANCIS T. McAVOY

GEORGE B. GEE

J. DONALD MITSCH

ARTHUR J. HARTY

CHARLES W. ROBINSON

HAROLD F. HEALD

JOSEPH A. TOMASELLO

LEROY M. HERSUM

LEON B. TURNER

FIELD AND OFFICE EQUIPMENT AND SUPPLIES FOR THE ENGINEER

*Instrument
Repairing*

*New and
Used
Transits
and
Levels*

*Blueprint
PAPER
Drawing*

*Blue Prints
Blue Lines*

*Black Lines
Photostats*

DRAFTING ROOM FURNITURE

B. L. MAKEPEACE, INC.

387 WASHINGTON STREET, - 394 BOYLSTON STREET
BOSTON, MASS.